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## TRANSACTIONS

## ABSTRACTS

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# DATES OF PUBLICATION

# Cytological Studies on Triticum and Aegilops II

## On the Genus Crosses between Triticum and Aegilops

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With Plates I–VII

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# Introduction

Since some years the cytological behaviour of the crosses between two systematically closely related genera *Triticum* and *Aegilops* was the subject of the writer's study. Not only does it elucidate the affinity existing between the chromosomes of these two genera, but also it will throw light on the important problem, how the formation of *Triticum* species has taken place in the course of the phylogenetic development.

The present study chiefly concerns the somatic and meiotic chromosomes of $F_1$ plants produced by the crosses between certain species of *Triticum* and *Aegilops*. The relation between the chromosome number and the size of pollen grains in *Aegilops* species is also one of the subjects treated of in this paper.

# Material and Methods

The species used for the present study are as follows:

| Species | Agronomic Variety |
|---|---|
| *Triticum vulgare* HOST. | Komaba, No. 3 |
| *T. vulgare* HOST. | U.A.C. (Utsunomiya Agricultural College), No. 1 |
| *T. durum* DESF. | Blé dur de Médéah |
| *Aegilops cylindrica* HOST. | |
| *A. ovata* L. | |
| *A. squarrosa* CAV. | |
| *A. triuncialis* L. | |
| *A. speltoides* TAUSCH. | |

Among these species the crosses have been made according to the following combinations:

> *T. vulgare*, Komaba, No. 3 × *A. cylindrica*
> *T. vulgare*, U.A.C., No. 1 × *A. cylindrica*
> *A. cylindrica* × *T. vulgare*, Komaba, No. 3
> *T. durum*, Blé dur de Médéah × *A. ovata*.

In each species the number of chromosomes has been counted by means of BELLING's aceto-carmine II (BELLING, 1921) on the P.M.C.[1]

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(1) Abbreviation for pollen mother-cell.

except in *T. durum* in which the root tips taken from the kernels
placed on the wet filter-paper have been used. For the observation of
somatic chromosomes of the hybrid plants the $F_1$ seeds have been sown
on the moistened filter-paper and also in the pots filled with soil. In
both cases the root tips were fixed in FLEMMING's median solution and
in BENDA's solution without acetic acid. The root tips of *Aegilops*
species have been fixed also in these two fixatives. For the observa-
tion of $F_1$ meiosis in the P.M.C.-s BELLING's aceto-carmine II has
chiefly been employed, but at the same time the anthers were fixed in
BOUIN's fluid with 1% urea, and also by KIHARA's method (KIHARA,
1924) using CARNOY's fluid and FLEMMING's solution. All fixed
materials above stated were imbedded in paraffin. The sections were
cut 16-17$\mu$ thick, and stained with HEIDENHAIN's iron alum haema-
toxylin. The permanent preparations of $F_1$ meiosis made from the
paraffin material were chiefly used to check the results obtained by
BELLING's method. For the preparation of mature pollen grains of
*Aegilops* species lactic acid was used. The preparations made by
BELLING's method were quite suited for the chromosome observation
of parents and of $F_1$ plants, and they have kept themselves clear for
months.

## Results and Discussions

### I.  TRITICUM VULGARE × AEGILOPS CYLINDRICA AND
### THE RECIPROCAL CROSS

#### (a)  *Sterility of $F_1$ Hybrids*

According to TSCHERMAK (1906, 1913, 1914)[1] the $F_1$ hybrids
between several species of wheat with *Aegilops ovata* and *A. cylindrica*
and also *A. ovata* with rye, were in most cases sterile. The anthers
were dry and remained closed. But that the sterility was not always
complete, at least for the female gametes, was shown by the occasional
formation of the kernel on the heads. Here the self-pollination as well
as the cross-pollination by pollen grains coming from outside might
have played a rôle in the fertilization. K. and H. SAX (1924) report
that the $F_1$ plants between *A. cylindrica* and a variety of *T. vulgare*
were completely sterile.

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(1)  Cited from LEIGHTY and others (1926).

In the above stated three kinds of crosses between *T. vulgare* and *A. cylindrica* I have obtained 67 $F_1$ hybrids in total. A large number of $F_1$ heads were bagged to protect them against the pollen grains coming from outside, while the others remained unprotected. The bags were afterward taken off when the flowers became too old to be cross-pollinated, and thus the unfavourable effect of bagging upon fruit formation was avoided.

The $F_2$ kernels obtained thus are shown in Table I.

TABLE I.  Sterility of $F_1$ plants between *T. vulgare* and *A. cylindrica*

| $F_1$ | Number of plants | Number of heads | | Number of spikelets | | Number of kernels | | % of kernel production to the number of spikelets | |
|---|---|---|---|---|---|---|---|---|---|
| | | Bagged | Unprotected | Bagged | Unprotected | Bagged | Unprotected | Bagged | Unprotected |
| *T. vulgare*, Komaba No. 3 × *A. cylindrica* | 29 | 438 | 560 | 5519 | 7779 | 1 | 27 | 0.018 | 0.35 |
| *T. vulgare*, U. A.C., No. 1 × *A. cylindrica* | 23 | 350 | 555 | 4288 | 6661 | 0 | 13 | 0 | 0.20 |
| *A. cylindrica* × *T. vulgare*, Komaba, No. 3 | 15 | 395 | 438 | 4615 | 5585 | 0 | 27 | 0 | 0.48 |

In my $F_1$ plants the anthers did not open usually, but it may be considered that the occasional breaks of anther have resulted in the formation of a single kernel in a bagged $F_1$ head of *T. vulgare*, Komaba, No. 3 × *A. cylindrica*. The kernel production was greater on the unprotected heads than on bagged heads, which may be due chiefly to the unfavourable conditions of temperature and moisture inside the bag. The kernels set on unprotected heads may have been produced either by cross- or self-pollination.

407 back-pollinations with pollen grains of both parents were made on 19 $F_1$ plants of different parental combinations, and one kernel was obtained in the cross (*T. vulgare*, U.A.C., No. 1 × *A. cylindrica*) × *A. cylindrica*.

Thus it may be said that the $F_1$ hybrids between *T. vulgare* and *A. cylindrica* under discussion are not completely sterile though the degree of sterility is very high.

### (b)  *Morphological Characters of Parents and F₁ Hybrids*

F₁ plants grow much more vigorously than either of their parents. In *A. cylindrica* (Fig. 35) the rachis may be easily broken at the base of the spikelets, and the short and hard denticulation is observed on the margin of the rachis. The keel of the empty glume is not observed. In the uppermost spikelet both the empty and the outer glume are long-awned, but in the lower ones the empty glume has a shorter awn or merely an apical tooth, while the outer glume has none.

In *T. vulgare*, Komaba, No. 3 and U.A.C., No. 1 (Fig. 36 and Fig. 37) the rachis is tough and has long and soft hairs on the margin. The keel of the empty glume is evident. In all spikelets, wherever placed in the rachis, the outer glume has a long awn, while the empty glume presents only a short apical tooth.

The morphological characters of F₁ plants of two varieties of *T. vulgare* and *A. cylindrica* are intermediate between them as regards the presence of keel on the empty glume, the brittleness of rachis, the size and hardness of the hairs or denticulation of the margin of rachis, the length and distribution of awn, breadth of empty and outer glume. One of the F₁ spikes is shown in Fig. 38. The reciprocal cross gave the F₁ plants having the same intermediate characters.

### (c)  *Cytology of F₁ Hybrids*

The haploid chromosome number of *T. vulgare*, Komaba, No. 3 and of *T. vulgare*, U.A.C., No. 1 was counted as 21 (Fig. 1, 2),[1] while that of *A. cylindrica* was confirmed to be 14 (Fig. 3).

The chromosome behaviour in the meiosis of P.M.C.-s of F₁ plants obtained by the crosses between two varieties of *T. vulgare* and *A. cylindrica*, and also by their reciprocal cross are observed to be analogous with each other, any notable difference being not detected.

### (1)  The Somatic Number of Chromosomes

In F₁ 21 haploid chromosomes from *T. vulgare* and 14 haploid chromosomes from *A. cylindrica* are brought together, so that the

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(1)  For the explanation of figures s. p. 23 ff.

chromosome number in somatic cells should be 35.  This was actually
confirmed in the root tips of F₁ of *T. vulgare*, Komaba, No. 3 × *A.
cylindrica* (Fig. 4).  The somatic chromosomes in these root tips are
very slender.  About the same number of chromosomes was observed
by K. and H. SAX (1924) in the F₁ between *A. cylindrica* and a variety
of *T. vulgare* as the diploid number, and PERCIVAL (1926) also reports
35 to be the diploid number in F₁ of *A. ovata* (X=14) × *T. vulgare*
(X=21).  In both cases the counting was made on chromosomes in the
meiosis of the P.M.C., but not in the somatic cells.

## (2)  The First Meiotic Division

K. and H. SAX (1924) observed in the heterotypic division of the
P.M.C. of the above cited F₁ between *Triticum* and *Aegilops* about 7
bivalent and 21 univalent chromosomes.  In my material of three kinds
of parental combinations usually 7 bivalent and 21 univalent chromo-
somes are clearly counted on the equatorial plane (Fig. 5, 6, 7).

Bivalent chromosomes can in most cases be distinguished from
univalent according to their greater breadth.  The bivalents arrange
themselves in the central portion of the equatorial plate, and the
univalents are located in its periphery.  On the other hand it is
frequently observed that a large number out of 21 univalents are
scattered in the cytoplasm while the bivalents and usually 3-7 uni-
valents are arranged in the equatorial region.  Some of these scattered
univalents are located at the poles or near them.  These conditions can
be seen in Fig. 8, which is a side view of a P.M.C., where three
bivalents are already or nearly separated into halves.  I think that
most of the figures of these kinds, though possibly not all of them,
present the stage immediately following the period in which 7 bivalents
and 21 univalents are arranged on the equatorial plane.  The number
of univalents located outside the equatorial plane between the latter
and either pole is usually 5-11.  Occasionally 6 bivalents are counted
instead of 7, together with 23 univalent chromosomes.  In certain
cases more than 21 univalents are counted when the number of
bivalents is 7.  For instance, 6 bivalents and 25 univalents are shown
in Fig. 9.  In this figure 2 out of 25 univalents should probably be two
divided halves of a single bivalent, but there still remain 23 univalents.
This is perhaps brought about by the longitudinal division of two of
the 21 univalent chromosomes.  The longitudinal split of all univalents

takes place in the following period of meiosis, as will be stated later. But occasionally this split seems to occur in certain univalents much earlier than usual, thus increasing the number of univalents. In some cases the number of univalents is less than 21. This is perhaps owing to the grouping of chromosomes unfavourable for observation which renders the exact counting difficult.

As to the modes of chromosome mating to form gemini in the hybrid meiosis, there can be two possibilities: (1) a geminus may be formed between two chromosomes which are derived from different parents or (2) the mating may take place between two chromosomes derived from either one of the two parents. SAX (1922) and KIHARA (1924) observed in the first meiotic plate of the $F_1$ between Emmer and Vulgare groups of *Triticum*, 14 bivalent and 7 univalent chromosomes. They were of the opinion that these 14 bivalents are formed between 14 chromosomes derived from Emmer group and 14 chromosomes derived from Vulgare group. In the meiosis of the P.M.C. of $F_1$ of *A. ovata × T. vulgare* PERCIVAL (1926) found no typical bivalent chromosomes, the 35 univalent chromosomes having been irregularly distributed on the heterotypic spindle and some apart in the cytoplasm. In $F_1$ of *A. ovata × T. dicoccum* he observed that the pairing of chromosomes in the heterotypic division was only of loose kind. PERCIVAL, however, suggests the possibility that in the hybrids of these genus crosses the mating of chromosomes may take place among *Triticum* chromosomes or among *Aegilops* chromosomes respectively.

In my material it is difficult to say, according to which mode the 7 bivalent chromosomes are formed, because the chromosomes of both parents are apparently so similar in the size and shape that they cannot be distinguished from each other. If it is allowable to consider, however, that the bivalent chromosomes are formed between the chromosomes derived from different parents, and if the compactness of mating may indicate the greater affinity of the chromosomes, then it can be said that between *A. ovata* and *T. vulgare* and also between *A. ovata* and *T. dicoccum* it is weaker than between *A. cylindrica* and *T. vulgare*. According to PERCIVAL (1921) *T. vulgare* may have been derived from the cross or crosses of *T. dicoccoides* (*T. dicoccum*, *T. durum*) with *A. cylindrica* and *A. ovata*. GAINES and AASE (1926) suggest that the 21 haploid chromosomes of *T. vulgare* are composed of three different sets of 7 chromosomes. They assumed also that

each of the 14 haploid chromosomes of *T. turgidum* and of *A. cylindrica* is composed of two different sets of 7 chromosomes respectively. They further proposed the hypothesis that the two sets out of three of *T. vulgare* are similar to two sets contained in *T. turgidum*, while one set of *T. vulgare* is similar to one set of *A. cylindrica*. On the other hand, the writer (1927), in view of the observations on the size and shape of somatic chromosomes of *T. vulgare*, has reported, that they were not phylogenetically derived from the multiplication of a basic set of 7 chromosomes, which is favourable for the conception of GAINES and AASE. It may be considered that the 7 bivalent chromosomes observed by other investigators as well as by the writer are composed of 7 chromosomes of *A. cylindrica* derived from one of the parents in the experimental crosses and 7 chromosomes of *T. vulgare*, which were derived from *A. cylindrica* in the phylogeny of this *Triticum* species, and are contained at present in a number of its varieties.

In the next stage the divided halves of bivalent chromosomes are separated out normally from each other and begin to move toward the heterotypic poles, the homotypic split being formed subsequently. SAX (1922) and KIHARA (1924) observed, in the first meiotic division of the $F_1$ hybrids between Emmer and Vulgare groups, that usually 7 univalents arranged themselves on the equatorial plane after the bivalents were divided and began to pass toward the poles. The same condition was observed by THOMPSON (1926) in the first meiotic division of $F_1$ between *T. monococcum* and *T. turgidum*, where 3-7 bivalents and 15-7 univalents were counted. But in certain cases hitherto reported by investigators where the number of univalents is comparatively large compared to that of the bivalents, the arrangement of univalents in the equatorial region after the divided halves of bivalents begin to pass to poles is much disturbed. KIHARA (1924) observed in $F_1$ meiosis of *T. dicoccum* × *T. monococcum*, where 4-7 bivalents and 13-7 univalents were counted, that some univalents were often located at the heterotypic pole when the others arranged themselves in the equatorial region. In the $F_1$ meiosis of *T. Spelta* × *T. monococcum*, where 0-5 bivalents and 28-18 univalents were observed, MELBURN and THOMPSON (1927) found that only 7-13 univalents showed this equatorial arrangement, while the others which are located nearest the heterotypic poles in the beginning, remained outside the equatorial plane, and subsequently most of the latter ones joined the divided bivalents.

In my material where the univalents are quite numerous as compared to the bivalents, only 5-9 univalents are observed in the

equatorial region after the bivalents are divided and carried toward the poles. One of these conditions can be seen in Fig. 10. In this figure 5 univalents in the equatorial region and two univalents outside it are homotypically split. But larger numbers out of 21 univalents remain in the position where they were located since earlier period of the division and join the groups of divided halves of bivalents when they pass to the poles.

In the meiosis of $F_1$ between Emmer and Vulgare groups of *Triticum* SAX (1922) and KIHARA (1924) observed that the univalents were all divided in the reduction division and the divided halves passed to different poles (*Triticum* type of chromosome behavior), joining there with the divided bivalents. These divided halves of univalents were, in the homotypic division, distributed by chance to either pole. In my material all the divided halves of bivalents and univalent chromosomes usually show homotypic split in the anaphase or in some cases in more or less earlier period of the first meiotic division. The unusually early split of certain univalents which occasionally may occur is already described above. In Fig. 11, 25 chromosome groups, each of which is composed of two chromosomes, are counted in the clump of chromosomes at about the equatorial region, and one group of chromosomes is separated, being located near a pole. There is almost no doubt that there are besides 9 chromosome groups, but they were not clearly counted and in this figure the places where such groups may lie are indicated by polygonal figures. The existence of two chromosomes in each group means the homotypic splitting which occurred in the divided halves of bivalents and also in the univalent chromosomes. To this figure we shall come again later.

In some cases the split halves of univalent chromosomes are actually separated and carried to different poles in the reduction division, as can be seen in Fig. 12. In this figure a pair of split halves of an univalent chromosome is already separated and the halves are being carried to different poles, while the split halves of other univalents are not being separated. But the actual separation of the divided halves of univalents was observed only in a few cases in the reduction division. Quite often the separation of the halves of univalents does not occur in all univalent chromosomes in the reduction division. Fig. 13 is a polar view of the heterotypic anaphase, and another group of chromosomes was observed in the other plane of focus. In this figure 21 groups of chromosomes, which are certainly composed of the divided

halves of bivalents and the entire univalents, are clearly observed. In each group two chromosomes which are formed by the splitting during anaphase or earlier period are shown, and there can be observed no single chromosome which would be a divided half of the univalent passing to the pole.

K. and H. SAX (1924) state on the meiosis of $F_1$ between *A. cylindrica* and a variety of *T. vulgare*, that in most cases 21 univalent chromosomes are apparently not divided in the heterotypic anaphase. The fact that in the heterotypic division some of the univalents are divided and the halves are carried to different poles while the others are carried to either pole without division, is observed by KIHARA (1924), THOMPSON (1926) as well as MELBURN and THOMPSON (1927) in the meiosis of different species hybrids of *Triticum*, by KIHARA (1924) in the meiosis of $F_1$ between *T. vulgare* and *Secale cereale*, by GAINES and AASE (1926) in a haploid wheat plant which was supposed to have arisen from *T. compactum*, and by PERCIVAL (1926) in the $F_1$ meiosis of *A. ovata* $\times$ *T. vulgare*. In certain of these cases the non-division of the univalents is observed to occur only in rare cases, while in other cases it was found more frequently. In my material the non-division of univalents takes place for most or all chromosomes, but occasionally the actual separation of the halves of univalents is observed, so that it can be said that there chiefly prevails the *Drosera* type (ROSENBERG 1909) of chromosome behaviour, somewhat combined with the *Pilosella* type (ROSENBERG 1917). At any rate we may say that the univalents in $F_1$ between different *Triticum* species and that between *Triticum* and *Aegilops* are homotypically split in the heterotypic division, though the separation of the divided halves takes place to more or less extent differing according to the kinds of the parent species used.

In my material the chromosomes which are lagging in the cytoplasm were in many cases observed in the late anaphase and in the early telophase of the reduction division (Fig. 14). They were either monad or dyad chromosomes, and in some cases it was difficult to distinguish them. The monads can be regarded as the divided halves of univalents and the dyads as the entire univalents. The number of monads and dyads in some cases, as observed in the $F_1$ of *T. vulgare*, Komaba No. 3 $\times$ *A. cylindrica* can be seen in Table II.

TABLE II.  The number of lagging chromosomes in late anaphase and in early telophase of reduction division.  M, monad chromosomes ; D, dyad chromosomes

| Sum of the number of lagging chromosomes | 0 | 1 | 2 | | 3 | | 4 | | | 5 | | | 6 | | | | 7 | | | | 8 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Composition of each case | 0 | 1M | 2M | 1D | 3M | 1M.1D | 4M | 2M.1D | 2D | 5M | 3M.1D | 1M.2D | 6M | 4M.1D | 2M.2D | 3D | 7M | 5M.1D | 3M.2D | 1M.3D | 8M | 6M.1D | 4M.2D | 2M.3D | 4D | |
| Frequency | 7 | 3 | 2 | 7 | 0 | 3 | 0 | 2 | 7 | 0 | 0 | 5 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | $n=42$ |

The data in this Table is summarized in Table III :

TABLE III.  The number of lagging chromosomes summarized

| Number of lagging chromosomes | 0 | 1M | 2M | 3M | 1D | 2D | 3D | 4D |
|---|---|---|---|---|---|---|---|---|
| Frequency | 7 | 12 | 5 | 1 | 12 | 14 | 3 | 1 |

Thus it can be said that in most cases only 1-2 divided halves of the univalents and 1-2 entire univalent chromosomes are found lagging in the reduction division though the number of the univalents is quite numerous.  The cases in which no lagging chromosomes are observed occur also rather frequently.  In the late telophase the additional clumps or masses of chromatic substance which are probably derived from the lagging chromosomes were observed in many cases (Fig. 15).

As is already stated, 7 divided halves of bivalents pass to poles normally.  In addition to these, 3-7 univalents which are usually located in the equatorial region together with the bivalents are distributed by chance to either pole.  In rare cases the split halves of these univalents may be distributed into different poles.  Besides there are counted usually 5-11 univalents located in the cytoplasm at both sides of the equatorial plane.  The number of such univalents is determined by

chance, and most of them join the mass of divided bivalents on their way to the pole. Some of these 5-11 univalents, however, may be located in the equatorial region when the bivalents are already divided and pass to poles. And such chromosomes are distributed to one of the two poles by chance, though occasionally their split halves may be carried to different poles. Thus it can be said, that the number of chromosomes which move toward the pole is in most cases $7+(3-7)+(5-11)$, i.e. 15-25. Most or all of these chromosomes are of double nature, while a few of them are of single nature. On the way to poles, however, some of these chromosomes may lag behind in the cytoplasm and cannot enter the telophasic nucleus. Thus the chromosome content which is actually present in the telophasic nucleus is $(15-25)-a$, where $a$ means the number of lagging chromosomes, and this includes in most cases 1-2 monad or dyad chromosomes or their combinations. In this way the two telophasic nuclei of the heterotypic division receive chromosome contents which are qualitatively different from each other regarding all or most of the 35 unpaired chromosomes of $F_1$.

In a number of P.M.C.-s the chromatic substance undergoes abnormal change during the heterotypic divison. The contents of these P.M.C.-s disorganize and do not proceed into the further process of nuclear division (Fig. 16). The monad cells are produced in this way from the P.M.C. though they are abortive.

A case of the fusion of P.M.C.-s was observed in $F_1$ of *T. vulgare*, U.A.C., No. 1 × *A. cylindrica*, as is seen in Fig. 17. This figure is drawn from two succeeding sections in a permanent preparation. At the left side of the figure 35 unpaired chromosomes which are certainly composed of 14 divided halves of bivalents and 21 univalent chromosomes are observed in two sections. In each chromosome the longitudinal split is observable with more or less clearness. This splitting is, as was described above in the normal P.M.C., no doubt chiefly the preparation for homotypic division. On the right side of the figure all chromosomes are not countable owing to the clumping of chromosomes unfavourable for observation, though some are observed on a spindle fibre. It is highly probable that this dumb-bell-shaped P.M.C. is formed by the fusion of two P.M.C.-s, and it can reasonably be considered that $2 \times 35$ unpaired chromosomes are contained in this giant cell. Similar conditions were reported by GAINES and AASE (1926), though not in the hybrids. They found in a haploid wheat plant (somatic chromosome number=21) which was supposed to have arisen from *T. compactum*,

that the fusion of P.M.C.-s took place forming giant protoplasmic masses. They observed also the formation of P.M.C.-s containing 42 unpaired chromosomes, and they considered it probable that these P.M.C.-s have been produced by the same origin as the giant protoplasmic masses. An example of giant P.M.C. which showed the usual round shape, instead of the dumb-bell shape, was found in one of my F₁ preparations made by BELLING's method. But unfortunately the stain was already away when observed, and the chromosome content could not be clearly made out.

### (3)  The Second Meiotic Division

In the meiosis of F₁ between *A. cylindrica* and a variety of *T. vulgare*, K. and H. SAX (1924) observed that the second division was as a rule regular, producing normal tetrads, though in a few cases extra nuclei were observed in the cytoplasm. But in my material a number of abnormalities is frequently observed in the second division. I found that most or all chromosomes arranging on the homotypic plate are dyads while only a few are monads. This corresponds exactly to the fact that the actual separation of the divided halves of the univalents was observed only in a few cases in the reduction division. In Fig. 18 perhaps two chromosomes are monads and the others are all dyads, while in Fig. 19 all are dyads. The dyads are derived either from the divided bivalents or univalent chromosomes, the split halves of which were not distributed to different poles in the heterotypic division, and the monads are derived from the heterotypic univalents, the split halves of which were actually separated.

It is confirmed in many cases that the number of chromosomes in the homotypic plate is in accord with that of chromosomes distributed to the heterotypic poles, i.e., (15-25)—*a*. In Fig. 18, nearly 2 monad and 18 dyad chromosomes are counted, and in Fig. 19 22 dyad chromosomes.

In the next stage the divided halves of the dyad chromosomes are separated and pass to the homotypic poles, while the monad chromosomes are distributed by chance to either pole or lag in the cytoplasm. In Fig. 20 which is a polar view of the homotypic anaphase 16 monad chromosomes are observed. Thus the two homotypic nuclei receive chromosomes contents which are qualitatively equal regarding the

dyad chromosomes but differing from each other regarding the monad chromosomes.

In certain cases another mode of chromosome distribution is observed in the second meiotic division. In Fig. 21 the right half of the P.M.C. presents the later stage of homotypic anaphase. But in the left half the dyad chromosomes are gathered in two groups in the upper and the lower position of the figure quite apart in different planes of focus. In Fig. 22 two groups containing dyad chromosomes are separated by a cell wall while the other half of the P.M.C. is found nearly in the homotypic metaphase. Thus it can be seen that in certain cases the split halves of each chromosome are not separated to different poles in the homotypic division, and these chromosomes are gathered in two groups further passing to the tetrad stage. Thus in these cases the qualitatively unequal distribution of chromosomes occurs also regarding the dyad chromosomes. The analogous condition was observed by ROSENBERG (1917) in a hybrid of *Hieracium excellens* × *H. aurantiacum* where certain univalent chromosomes did not divide in both first and second divisions of meiosis, and entered in the tetrad nuclei as the "bivalente Gebilde." PERCIVAL (1926) also found it possible that certain univalents do not divide in both of the meiotic divisions in $F_1$ of *A. ovata* × *T. vulgare*.

It is found occasionally in my material that a portion of cytoplasm containing no chromosome at all is cut off by the cell wall in the homotypic division, the analogous condition having been observed by PERCIVAL (1926) in the meiosis of $F_1$ of *A. ovata* × *T. vulgare*.

The lagging of chromosomes is quite frequently observed in the late anaphase and early telophase of the second division. The lagging chromosomes are in most cases the monads (Fig. 23, a) though rarely they are apparently the dyads. KIHARA (1924) observed in the meiosis of $F_1$ between *T. vulgare* and *Secale cereale* that the number of lagging chromosomes in the second division was very few compared to that in the first division. The number of lagging chromosomes in the late anaphase and in the early telophase of the second division of $F_1$ of *T. vulgare*, Komaba, No. 3 × *A. cylindrica* can be seen in Table IV. The number of chromosomes in this Table is that of the monad chromosomes, while that of the dyad chromosomes which are found lagging only rarely is not included here.

TABLE IV.  Number of lagging chromosomes in the second division

| Number of lagging chromosomes | 0 | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|---|
| Frequency | 28 | 24 | 23 | 7 | 2 | 1 | $n = 85$ |

In my cases the number of the halves of univalents which are actually distributed to different poles in the heterotypic division is quite small, and this should bring about only the small number of lagging monad chromosomes into the second division, as is shown in this Table.  The cases in which no lagging of chromosomes occurs are much more numerous in the second division than in the first.  Very frequently extra chromatic clumps which are probably made from lagging chromosomes are observed in the late telophase of the second division (Fig. 23, b).

During the homotypic division the cell contents undergo abnormal change in a number of P.M.C.-s, and they do not proceed to the further process of division (Fig. 24).  Thus the abortive dyad cells are produced from the P.M.C.-s.  The normal tetrad formation is frequently disturbed concerning the number and size of the cells formed, 3-6 cells are formed in a P.M.C. and the size of each differs greatly.  Dyad cells which apparently are morphologically normal in the late tetrad stage are also occasionally formed.  These can be seen in Fig. 25.

The young microspores are now separated, and the extra chromatic clumps are in many cases observed in them (Fig. 26).  Extra nuclei in the microspores have also been observed by BALLY (1919) and PERCIVAL (1926) in the meiosis of $F_1$ between *T. vulgare* and *A. ovata*, and PERCIVAL observed the same in $F_1$ of *A. ovata* × *T. dicoccum*. He observes in these hybrids the polyspory.

The pollen grains in the ripe anther differ greatly in size and frequently pollen grains of abnormal shape are observed as shown in Fig. 27.  In this figure N presents the single pollen grain of average size which is most frequently observed.  Most of the pollen grains are empty or contain only a scarce, shrunken substance.  Morphologically normal pollen grains are also occasionally found, though most of them may be non-functional.

As can be seen from what has been above stated the chromosome content in the pollen grain is very various owing to a number of determining causes taking place in the meiosis. The studies on $F_2$ plants may make clear what chromosome content is contained in the functional gametes produced by $F_1$ plants.

In the progenies of certain crosses among species of *Triticum* and *Aegilops*, TSCHERMAK and BLEIER (1926) found, as will be noticed soon after more in detail, the plants showing the chromosome number which is double of that expected in the $F_1$. In the $F_1$ between *T. vulgare* and *A. cylindrica*, it may not be impossible to expect, from what was stated above regarding Fig. 11, that in certain cases all of the 35 unpaired chromosomes are arranged in the equatorial region, each of which is split longitudinally. If a mitosis may take place, which separates these split halves to different poles homotypically, dyad cells may be formed, and the production of diploid pollen grains may be expected. In the case where the analogous phenomenon will occur in the female gametogenesis, it may be not impossible to have in the $F_2$ generation a plant having $2 \times 35$ somatic chromosomes. This may be granted as a possibility, but the actual chromosome behavior is, as is described above, usually different from such mode of chromosome distribution.

## II.   TRITICUM DURUM × AEGILOPS OVATA

The haploid number of chromosomes of *A. ovata* was counted in the P.M.C. as 14 (Fig. 28). The somatic chromosome number of *T. durum* was counted in the root tips as 28 (Fig. 29). The latter figure is drawn from a root tip which has been treated before the fixation with the dilute solution of chloral hydrate. So that the chromosomes appear shorter and thicker than those fixed in the usual way and the constrictions are clearly observable.

TSCHERMAK and BLEIER (1926) observed in the $F_5$ and $F_6$ hybrids of *A. ovata* (X=14) × *T. dicoccoides* (X=14) and *A. ovata* (X=14) × *T. durum* (X=14) (*Aegilotricum*) that 28 was the reduced number of chromosomes, and about 56 the somatic number. Both these hybrids were fertile and their reduction division and the formation of sexual cells took place normally as in the diploid plants. In $F_1$ hybrid between these species 14 haploid chromosomes should be brought together from both parents, so that it can be expected that 28 is the somatic number

of $F_1$. But the actual countings in later generations showed double the number expected, so that this doubling of chromosome number must have taken place somewhere. The authors consider that each of the chromosome sets of *Aegilops* and *Triticum* has undergone the doubling in these hybrids. But unfortunately the authors could observe neither the somatic number of chromosomes nor the meiosis of $F_1$ between these parents concerned.

Regarding the causes of occurrence of this *Aegilotricum* of TSCHERMAK and BLEIER, ROSENBERG (1926) suggests the possible occurrence of semiheterotypic division and the "Regressionskerne" in the meiosis of $F_1$ hybrid, as was observed by him (1917) in the apogamous *Hieracium* species. According to him a nucleus containing the diploid number of chromosomes, each longitudinally split, can be formed in a P.M.C., and by the division homotypically occurring on these chromosomes the dyad cells containing the diploid number of chromosomes are produced. These dyad cells do not divide further, but develop to the pollen grains. In this way the diploid nuclear division may take place in the P.M.C. as well as in the E.M.C.,[1] and consequently the male and female diploid gametes thus formed could produce $F_2$ hybrids having 56 somatic chromosomes.

In the spring of 1926 the crosses between *T. durum* and *A. ovata* have been made by the present writer and two $F_1$ plants were raised from 187 pollinations (Fig. 41). The root tips of a $F_1$ plant have been taken from the pot and were fixed when the plant was going to head. The somatic chromosomes of $F_1$ are slender and the number of them was counted clearly as 28. This can be seen in Fig. 30. Thus the chromosome number of $F_1$ root tips is simply the sum of the haploid chromosome numbers of the parents, and not their multiple. So it seems probable that the above stated TSCHERMAK and BLEIER's *Aegilotricum* derived from the cross between *A. ovata* and *T. durum* has neither been brought about by the diploid gametes produced in the parental generations nor by the chromosome doubling which occurred during or soon after fertilization between two normal haploid gametes of the parents. We have also no actual evidence to consider that this hybrid might have occurred by the polyspermy. It is probable, however, that the duplication of chromosome number must have resulted from the meiosis in $F_1$ though its occurrence may not be impossible in the meiosis of hybrid generations after $F_1$. PERCIVAL (1926) finds, from the

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(1) Abbreviation for embryo-sac mother-cell.

chromosome counting in the meiosis of P.M.C. of $F_1$ of *A. ovata* (X=14) × *T. dicoccum* (X=14), that the diploid number of chromosomes is 28. This coincides with my result regarding the numbers of chromosomes of parents as well as of $F_1$ hybrid. My material at hand was not enough to make clear the chromosome behaviour in the $F_1$ meiosis of *T. durum* × *A. ovata*. But the dyad cells or giant microspores, which appeared morphologically quite normal in the period soon after the liberation of the tetrad cells were occasionally observed. These can be seen in Fig. 31. In this figure N presents the microspore which is most frequently seen.

Considering these facts it is highly probable that in $F_1$ meiosis the functional diploid pollen grains containing 28 chromosomes are formed by the mode suggested by ROSENBERG or in some other possible way. If the male and female gametes having diploid number of chromosomes are thus formed, the $F_2$ hybrid showing 28 chromosomes as the reduced number may be expected. However the frequency producing such $F_2$ plants may be quite small. The single $F_1$ individual which grew on to maturity in my garden was completely sterile, and most of the pollen grains in the mature anthers were empty or contained only a shrunken substance.

### III. THE SIZE OF POLLEN GRAINS IN DIFFERENT SPECIES OF AEGILOPS

The relationship between the number of chromosomes and the size of cells in polyploid species has hitherto been studied by many investigators. The results obtained by the present writer in different species of *Aegilops* are presented below.

The chromosome numbers of *Aegilops* species which were counted in the P.M.C.-s and in root tips are shown in the following lines. In *A. cylindrica* the root tips were chloralized before fixation, and in *A. speltoides* and *A. ovata* they were fixed without chloralization.

|  | Reduced number | Somatic number |  |
|---|---|---|---|
| *Aegilops speltoides* ...... | 7 (Fig. 32) | 14 | .....Diploid |
| *A. ovata* .............. | 14 (Fig. 28) | 28 | |
| *A. cylindrica* .......... | 14 (Fig. 3) | 28 | .....Tetraploid |
| *A. squarrosa* .......... | 14 (Fig. 33) | | |
| *A. triuncialis*.......... | 14 (Fig. 34) | | |

The shape of pollen grains of these species is practically ellipsoid or ovoid. So the size of the pollen grain was calculated as the volume of the ellipsoid according to the formula $V = \frac{1}{6} Dd^2\pi$, where $V$ presents the required volume, $D$ the length and $d$ the breadth of the pollen grain. The results are shown in Table V.

TABLE V.   The size of pollen grains in *Aegilops* species

| Species | Length mean μ | Breadth mean μ | Number of pollen grains | | Volume μ³ | Ratio | Reduced chromosome number |
| | | | For length | For breadth | | | |
|---|---|---|---|---|---|---|---|
| A. speltoides | 50·0 | 41·5 | 350 | 160 | 45,090 | 1·00 | 7 |
| A. ovata | 52·4 | 47·9 | 250 | 180 | 62,951 | 1·40 | 14 |
| A. cylindrica | 57·8 | 50·2 | 275 | 150 | 76,265 | 1·69 | 14 |
| A. squarrosa | 55·7 | 54·7 | 271 | 150 | 87,263 | 1·94 | 14 |
| A. triuncialis | 64·9 | 51·9 | 250 | 150 | 91,533 | 2·03 | 14 |

As can be seen in this Table the size of the pollen grain of *A. squarrosa* and of *A. triuncialis* is practically twice that of the diploid species, *A. speltoides*, while in *A. ovata* and *A. cylindrica* it is somewhat smaller than twice the latter. In *Chrysanthemum* TAHARA (1921) observed that the size of the nucleus of the P.M.C. was different in different species with the same number of chromosomes. Further he found by comparing certain species that the size of the nucleus varies corresponding to the chromosome volume therein contained. But the comparison of *A. triuncialis* and *A. ovata* has shown me no evident difference between their chromosome size. This may possibly be owing to the foreshortening of the chromosomes.

## Summary

( 1 )   The F₁ plants between two varieties of *Triticum vulgare* and *Aegilops cylindrica*, and those produced by the reciprocal cross using one variety of *T. vulgare* are highly sterile, though not completely so.

( 2 )   The chromosome number in root tips of F₁ plants of *T. vulgare* × *A. cylindrica* is determined as 35, which is the sum of 21 haploid chromosomes of *T. vulgare* and 14 haploid ones of *A. cylindrica*.

( 3 )  The meiosis of the P.M.C.-s of the above stated three kinds of $F_1$ plants proceeds in an analogous way, not showing any notable difference.

( 4 )  In the heterotypic metaphase of the P.M.C.-s 7 bivalent and 21 univalent chromosomes are clearly counted, all of which arrange themselves on the equatorial plane.  But frequently 5-11 univalents are located in the cytoplasm in both sides of the same plane, while 3-7 univalents are arranged on the equatorial plane together with the bivalents.

( 5 )  The halves of the bivalents pass to heterotypic poles normally, the homotypic split being formed on the way.  After this 5-9 univalent chromosomes can be observed in the equatorial region.  But most of the univalents located outside the equatorial plane remain in their position as before.

( 6 )  In the anaphase of the heterotypic division or more or less earlier than that all the univalent chromosomes are homotypically split. These split halves are located somewhat apart from each other.  But in most or all cases they are not actually distributed to different poles, but are carried by chance toward either pole arranging side by side. But in some cases the halves are actually distributed to different poles.

( 7 )  The lagging of chromosomes is frequently observed in the reduction division, though cases showing no lagging are also observed. The laggards are, in most cases, 1-2 monad or dyad chromosomes or their combinations.

( 8 )  Most or all of the chromosomes entering the telophasic nucleus of the reduction division are the entire unpaired chromosomes, and some are the separated halves of the univalents.  This condition of chromosomes is revealed correspondingly in the homotypic metaphase, where we observe most or all chromosomes to be dyads, while a few are monads.

( 9 )  The number of chromosomes appearing in the homotypic metaphase corresponds to that in the telophasic nucleus of the heterotypic division.

(10)  The halves of the dyad chromosomes go normally to homotypic poles, but the monad chromosomes are distributed at random to either pole or they may lag in the cytoplasm.

(11)  In certain cases the halves of dyad chromosomes are not separated in different homotypic poles, but the dyad chromosomes themselves pass to either pole without separation, and the P.M.C. passes into the tetrad stage.

(12)  In the homotypic division the lagging of chromosomes is also often observed.   These chromosomes are in most cases 1-2 monads. The cases showing no lagging are more numerous than in the reduction division.

(13)  A case of the fusion of two P.M.C.-s is observed.   The resulting giant cell contains two sets of diploid number of chromosomes.   Dyad and monad cells are occasionally formed from the P.M.C.-s, though they are in most cases abortive.

(14)  The extra nuclei in the premature microspores and the polyspory in the tetrad formation are frequently observed.   The pollen grains differ greatly in size, and often their fusion takes place.

(15)  Thus the chromosome content in the pollen grain becomes quite irregular, though it may be assumed that there are contained normally in a single pollen grain a set of 7 chromosomes derived from the bivalent chromosomes and various numbers of derivatives of the 21 univalent chromosomes.

(16)  Most of the mature pollen grains are abortive, but occasionally pollen grains which are morphologically normal are observed. However, most of the latter, though not all of them, may be non-functional.

(17)  The chromosome number of root tips of a $F_1$ plant of *Triticum durum* × *Aegilops ovata* is 28, the sum of two haploid chromosome numbers of both parents.   The formation of dyad cells and giant microspores is observed in the $F_1$ meiosis.

(18)  It is probable that the TSCHERMAK and BLEIER's *Aegilotricum* having 28 haploid chromosomes in the progeny of *Aegilops ovata* (X=14) × *Triticum durum* (X=14) was produced by diploid gametes which may have been formed in the $F_1$ meiosis.

(19)  The ratio of the size of pollen grains to that of a diploid species is more or less different, in different species of *Aegilops* having the tetraploid number of chromosomes ranging from 1.40 to 2.03.

Nov. 1927, UTSUNOMIYA.

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# Explanation of Plates  I—VII

All figures in Plates I—V are drawn with the aid of ABBE's large camera. ZEISS apochromatic objective 1.5 mm., achromatic $\frac{1}{12}$ Fl. and DD were used in combination with all kinds of ZEISS compensation oculars. These figures are, if not otherwise stated, drawn from preparations made by BELLING's method.

### PLATE  I

Fig. 1–3.  Heterotypic division of the P.M.C. of parent species. ×1690.

Fig.  1.  *Triticum vulgare*, Komaba, No. 3.
Heterotypic anaphase.  Polar view (X=21).

Fig.  2.  *T. vulgare*, U.A.C., No. 1.
Heterotyic metaphase.  (X=21).

Fig.  3.  *Aegilops cylindrica*.
Heterotypic metaphase.  (X=14).

Fig.  4.  F₁ of *T. vulgare*, Komaba, No. 3×*A. cylindrica*.
Somatic nuclear plate showing 35 chromosomes.  Permanent preparation. ×4450.

Fig. 5–8.  Heterotypic division of the P.M.C. of F₁ plants between *T. vulgare* and *A. cylindrica*. ×1690.

Fig.  5.  *T. vulgare*, Komaba, No. 3×*A. cylindrica*.
7 bivalents and 21 univalents.  Polar view.

Fig.  6.  *T. vulgare*, U.A.C., No. 1×*A. cylindrica*.
7 bivalents and 21 univalents.  Polar view.

Fig.  7.  *A. cylindrica*×*T. vulgare*, Komaba, No. 3.
7 bivalents and 21 univalents.  Polar view.

Fig.  8.  *T. vulgare*, Komaba, No. 3×*A. cylindrica*.
One of the 7 bivalent chromosomes is already divided, two are going to be so.  21 univalents.  Side view.

### PLATE  II

Fig. 9–15.  Heterotypic division of the P.M.C. of the F₁ plants between *T. vulgare* and *A. cylindrica*. ×1690.

Fig. 9. *T. vulgare*, Komaba, No. 3×*A. cylindrica*.
6 bivalents and 25 univalents. Side view.

Fig. 10. *T. vulgare*, U.A.C., No. 1×*A. cylindrica*.
Heterotypic anaphase. 5 univalents which are homotypically split are arranged in the equatorial region.

Fig. 11 *T. vulgare*, U.A.C., No. 1×*A. cylindrica*.
Heterotypic metaphase. Chromosomes are homotypically divided.

Fig. 12. *T. vulgare*, Komaba, No. 3×*A. cylindrica*.
Heterotypic anaphase. Separation and non-separation of split halves of univalents.

Fig. 13. *T. vulgare*, U.A.C., No. 1×*A. cylindrica*.
Polar view of heterotypic anaphase. Each of 21 unpaired chromosomes is homotypically split.

Fig. 14. *T. vulgare*, Komaba, No. 3×*A. cylindrica*.
Heterotypic telophase. Lagging of chromosomes ; one monad and two dyad chromosomes.

Fig. 15. *T. vulgare*, Komaba, No. 3×*A. cylindrica*.
Heterotypic telophase. Extra chromatic body and masses.

Fig. 16. *T. vulgare*, Komaba, No. 3×*A. cylindrica*.
Abnormal change and disorganization of the contents of P.M.C. during heterotypic division. ×1210.

## Plate III

Fig. 17. *T. vulgare*, U.A.C., No. 1 ×*A. cylindrica*.
Fusion of two P.M.C.-s. Drawn from two succeeding sections in a permanent preparation. ×1630.

Fig. 18–22. Homotypic division of the P.M.C. of $F_1$ plants between *T. vulgare* and *A. cylindrica*.

Fig. 18. *T. vulgare*, Komaba, No. 3×*A. cylindrica*.
Homotypic metaphase. About 18 dyad and 2 monad chromosomes. ×1850.

Fig. 19. *T. vulgare*, Komaba, No. 3×*A. cylindrica*.
Homotypic metaphase. 22 dyad chromosomes. ×1850.

Fig. 20. *T. vulgare*, U.A.C., No. 1×*A. cylindrica*.
Polar view of homotypic anaphase. 16 monad chromosomes. ×1850.

Fig. 21.  *T. vulgare*, Komaba, No. 3 × *A. cylindrica*.
 Homotypic anaphase.  In the left half of the P.M.C. dyad chromosomes are gathered in two groups. ×1690.

Fig. 22.  *T. vulgare*, Komaba, No. 3 × *A. cylindrica*.
 In the left half of the P.M.C. two groups containing dyad chromosomes are separated by a cell wall. ×1690.


## PLATE IV

Fig. 23–24.  Homotypic division of the P.M.C. of F₁ plants between *T. vulgare* and *A. cylindrica*.

Fig. 23, a.  *T. vulgare*, Komaba, No. 3 × *A. cylindrica*.
 Homotypic anaphase and telophase showing lagging monad chromosomes. ×1690.

Fig. 23, b.  *T. vulgare*, Komaba, No. 3 × *A. cylindrica*.
 Homotypic telophase.  Extra chromatic clump. ×1690.

Fig. 24.  *T. vulgare*, Komaba, No. 3 × *A. cylindrica*.
 Abnormal change and disorganization of the contents of cells during and after homotypic division. ×1210.

Fig. 25.  *T. vulgare*, U.A.C., No. 1 × *A. cylindrica*.
 Types of abnormal tetrad.  One of the microspores contains an extra chromatic clump. ×890.

Fig. 26.  *T. vulgare*, Komaba, No. 3 × *A. cylindrica*.
 Premature pollen grain containing one extra nucleus. ×1030.

Fig. 27.  *A. cylindrica* × *T. vulgare*, Komaba, No. 3.
 Types of pollen grains in the ripe anther. ×390.

Fig. 28.  *A. ovata*.
 Heterotypic metaphase.  (X=14). ×1690.


## PLATE V

Fig. 29.  *T. durum*.
 Metaphasic plate in the chloralized root tip fixed in BENDA's solution. 28 chromosomes with constrictions.  Permanent preparation. ×3340.

Fig. 30.  F₁ of *T. durum* × *A. ovata*.
 Metaphasic plate in the root tip.
 28 chromosomes.  Permanent preparation. ×4450.

Fig. 31.   F₁ of *T. durum* × *A. ovata*.
Types of microspores.
Dyad cell, giant and normal microspores. ×750.

Fig. 32–34.   Heterotypic metaphase of the P.M.C. of *Aegilops* species. ×1690.

Fig. 32.   *A. speltoides*   (X=7).

Fig. 33.   *A. squarrosa.*   (X=14).

Fig. 34.   *A. triuncialis.*   (X=14).


## PLATE  VI

Spikes of parents and hybrid.

Fig. 35.   *Aegilops cylindrica.*

Fig. 36.   *Triticum vulgare*, Komaba, No. 3.

Fig. 37.   *T. vulgare*, U.A.C., No. 1.

Fig. 38.   F₁ of *T. vulgare*, Komaba, No. 3 × *A. cylindrica.*


## PLATE  VII

Spikes of parents and hybrid.

Fig. 39.   *T. durum.*

Fig. 40.   *A. ovata.*

Fig. 41.   F₁ of *T. durum* × *A. ovata.*

PLATE I



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PLATE II



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PLATE III



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PLATE IV

23, a

23, b

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N

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PLATE V



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*N*
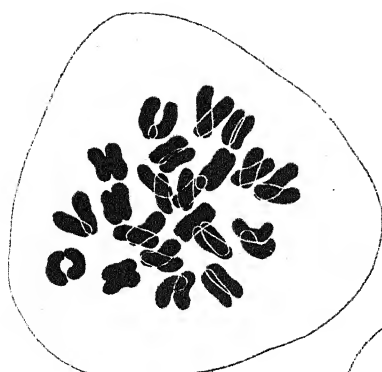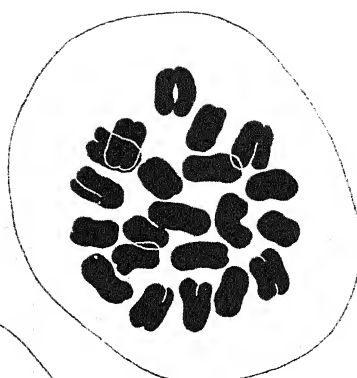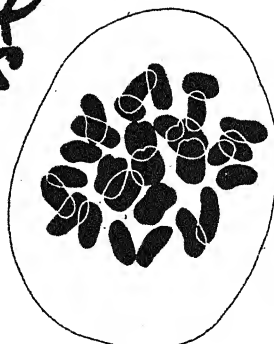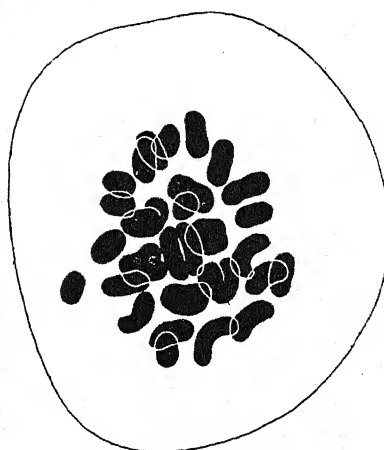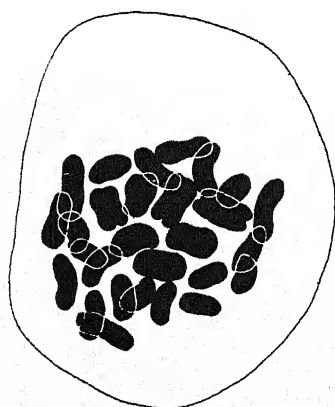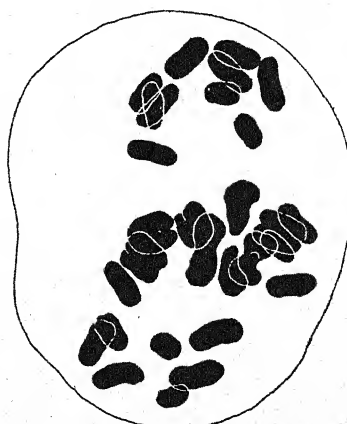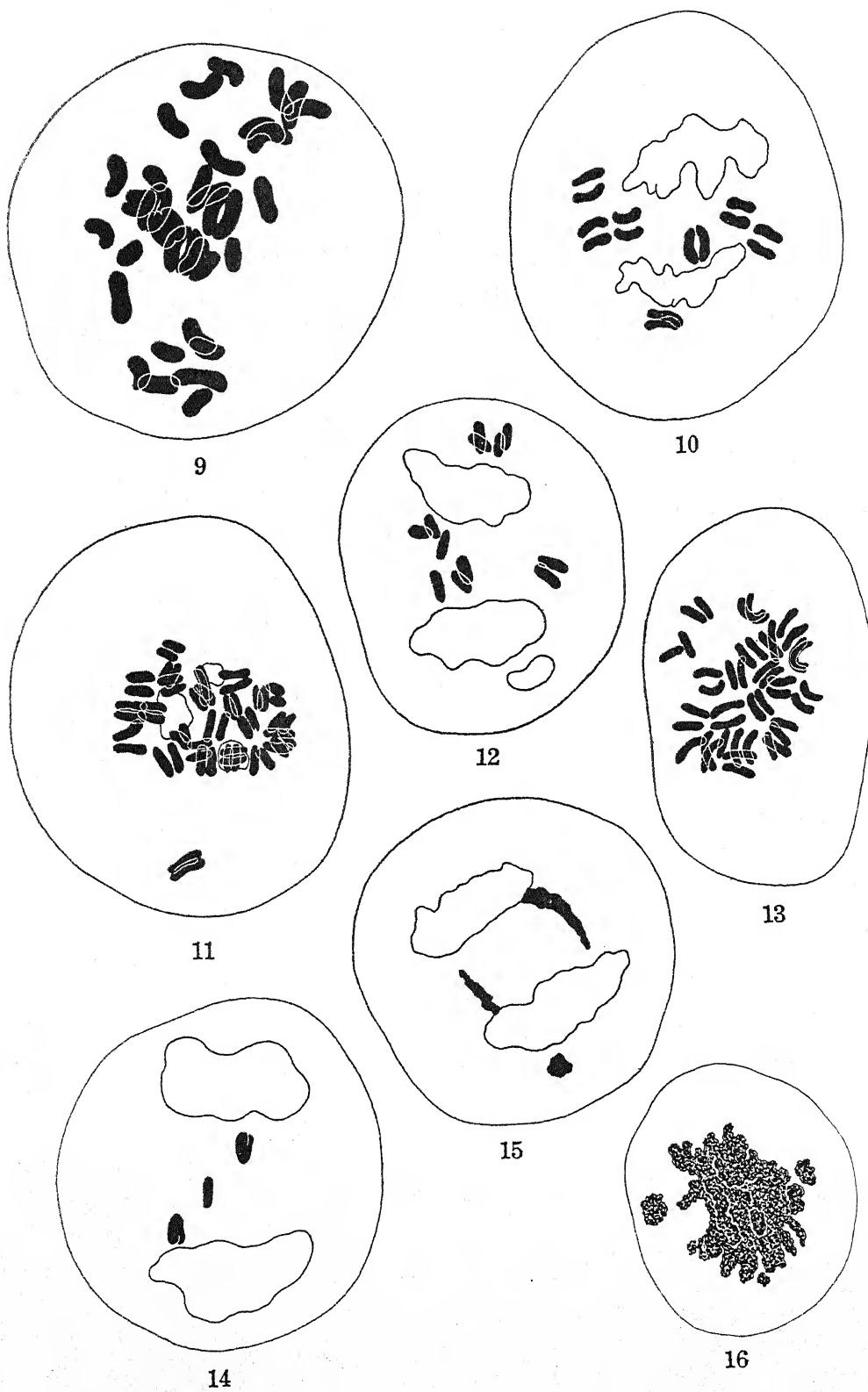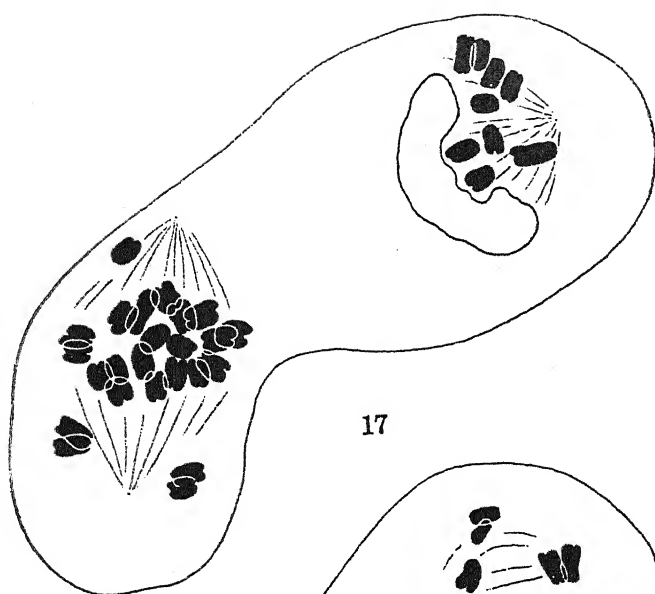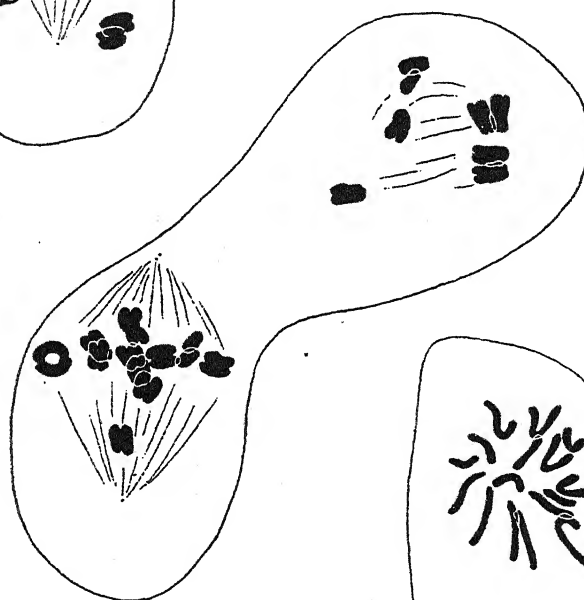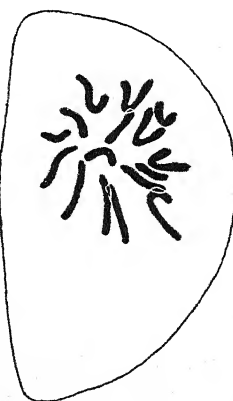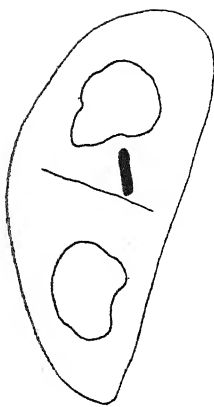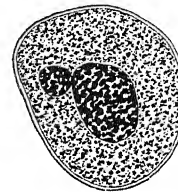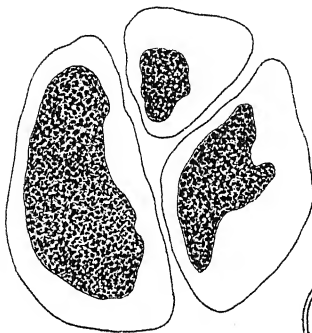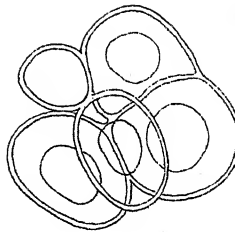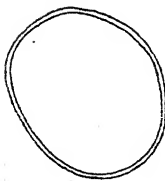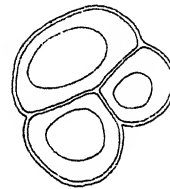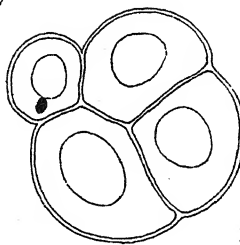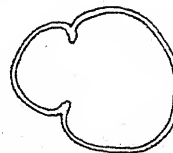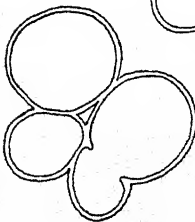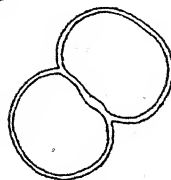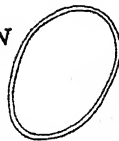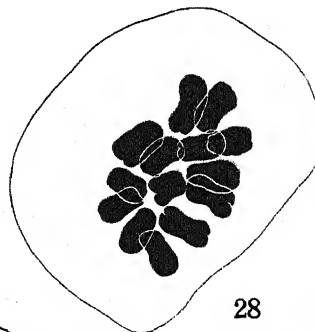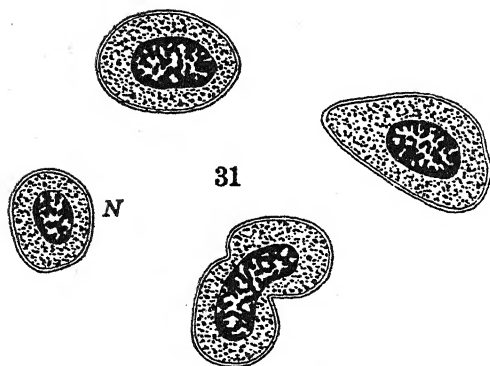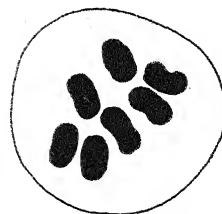


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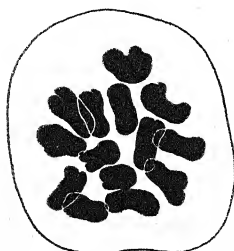


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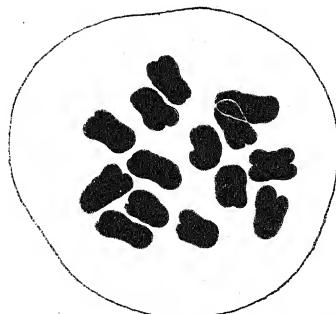


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PLATE VI



35        38        37        36

PLATE VII
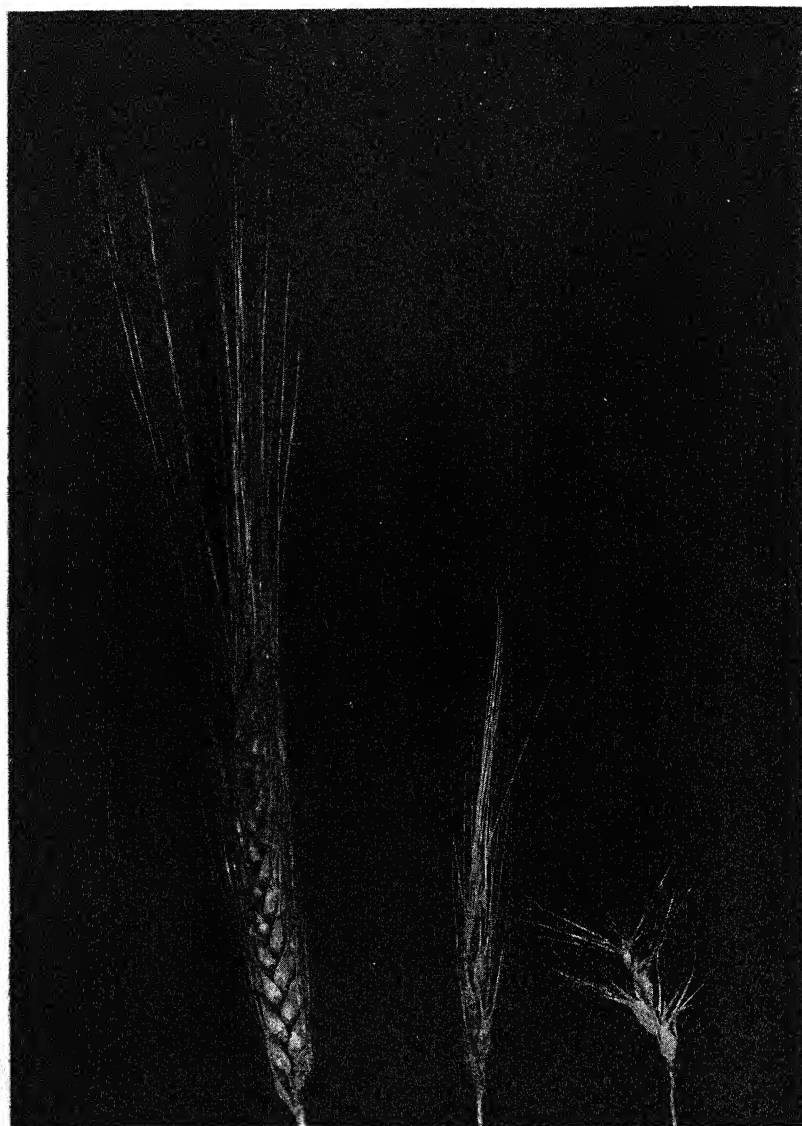


39          41          40

# Studies on Regeneration in Bryophyllum calycinum

## (Preliminary Note)

By Kinzirô KAKESITA

(Botanical Institute, Hokkaido Imperial University, Sapporo, Japan)

With Three Figures in Text

The causes of the restitution of tissues or organs of various plants were studied by several authors. LOEB mentioned, in his work on regeneration in *Bryophyllum calycinum*, that the research on regeneration should also concern the quantitative method. Basing upon his so-called quantitative experiments, he pointed out the accumulation of the assimilated substance as a main factor to cause the regeneration in this plant, instead of introducing some idea of a hormone or a specific matter. In other words, according to LOEB, when the sap is accumulated in the plant body by mutilation or other similar causes, the regeneration takes place.

The facts, which are contrary to or in favour of LOEB's theory have been reported, for example, the results of BRAUN (1918), CHILD and BELLAMY (1920), SMITH (1921), REED (1923), and others.

The present work was attempted to furnish some materials for the explanation of the regeneration in *Bryophyllum calycinum*.

*Bryophyllum* plants, used for the present investigation, had been supplied from the Department of Horticulture of the same University about three years ago, and propagated vegetatively by the writer in a greenhouse. Some of the plants flowered in February 1927, but the majority did not. The individuals, employed as the experimental material, belonged to the latter group. Healthy plants which were free from injuries and parasites, were carefully chosen for this purpose.

# Regeneration in the Attached Leaves
## of Bryophyllum calycinum

*Bryophyllum calycinum* has a character to regenerate its complete form, i.e., the roots and shoots, on a leaf, on a piece of leaf with notch, or a piece of stem, when it is isolated from the mother plant and kept in a wet condition. But it is possible to induce such regeneration on the leaf, which attaches to the mother plant, by giving some treatment, for instance, by applying a low temperature on the petiole ("the physiological isolation" by CHILD and BELLAMY, (1920)), or by placing the plant in the dark room (REED, 1923). Similar experiments were successfully attempted by the writer in the following ways. By ringing in the stem, or removing the wood portion from a part of the stem, the formation of roots and shoots was caused under the moist condition at the notches of the attached leaves, usually above, sometimes below the operated portion. To apply the warm bath method was also successful in producing roots and shoots at the notches of the attached leaves, as will be stated in detail in the following pages.

Recently, BORESCH (1924, 1926) studied experimentally the forcing action of the warm bath in the case of the bud-development of the plant in the resting state, based on the opinion that the warm bath causes the intramolecular respiration, and this kind of respiration produces the end and intermediate substances of alcoholic fermentation. Further, he succeeded in the experiments of the forcing action on the resting bud, by the injection of some of the end and intermediate products of alcoholic fermentation. From these results he concluded that the warm bath caused the formation of the end and intermediate products of alcoholic fermentation in the plant body, and among these substances especially acetaldehyde worked as the stimulant to force the bud-development.

Assuming that analogous phenomena might occur in the case of the regeneration in *Bryophyllum calycinum*, the following three parallel series of experiments were carried out:

1. The warm bath method.

2. Introduction of intramolecular respiration.

3. Injection of some chemicals which are considered to be intermediate substances of alcoholic fermentation.

### 1.  *Warm Bath Method*

In these experiments MOLISCH's (1915) warm bath method was employed.

*Experiment* A.  The plants, about 30–50 cm. in height and about one year old, were submerged in a warm bath of about 30°—35°C. for 8 hours[1] in the laboratory.  After warm bathing, the materials were placed in a greenhouse.  Some of them were covered with bell jars to keep them in a more or less moist condition, and some others were dipped with the apex of the treated leaves into water.  In both cases, the supply of fresh air was carefully considered.  After a few days, the young leaves, attached near to the main tip, decayed in some materials.  This symptom was observed more in the summer.  But the majority of them were sound and showed no change.  After about 5–10 days (at 20°—25°C.), the roots appeared in the notches of the treated leaves, except the very young leaves near the top, and soon the shoots formation followed (Fig. 1).  These regenerated young plants grew on for a long time. Some of them were planted in a pot after 3–4 weeks from the beginning of their development, together with their mother leaves without taking away from the stem.  They are still living (over one year). In some cases the untreated leaves of the same plant also produced new plants.  In other cases, both in the treated or untreated part of the
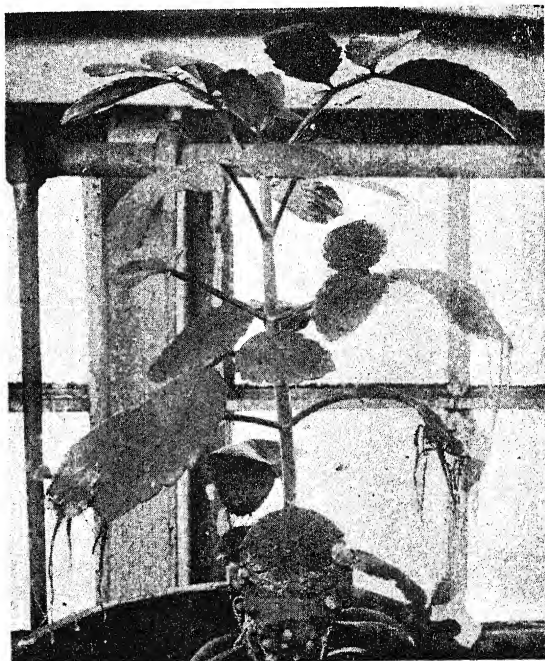


Fig. 1

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(1)  In the summer a shorter duration is favourable.

stem, adventive roots only were formed. On the control materials, no such regeneration took place.

*Experiment* B. The young plants of 2–3 months old, still attached to the isolated mother leaves, were used in this experiment. The young plants were immersed together with their mother leaves in a warm bath of about 35°C. for 8 hours. Then the whole materials were put in the moist chamber of the greenhouse, keeping the mother leaves in water. About 10–15 days later, the regenerated roots began to appear at the notches of the leaves on the middle and lower level of the young plants, sometimes accompanied by very tiny shoots. But these regenerated parts soon disappeared.

A similar phenomenon of the regeneration was observed in the moist air when the temperature suddenly rose for an adequate period. Isolated leaves of *Bryophyllum calycinum*, which possessed the young plants at their notches, were placed in a moist chamber in the greenhouse from October to December 1926. In the beginning the weather was rainy or cold, but it was followed by a short spell of fine weather for about 10 days, while the temperature in the moist chamber rose suddenly and remained at about 30°C. for some time. The young plants, which developed on the isolated mother leaves, regenerated the roots vigorously at the notches of their own leaves, chiefly on the middle and lower part of the stem. These regenerated roots soon drooped. Some other healthy plants of 15–20 cm. in height were placed near the hot water-pipes in the greenhouse. They regenerated the roots and shoots at the notches of the leaves attached to the middle and lower level of the plants. These newly produced parts lived for a long time. The temperature in that corner of the greenhouse registered sometimes higher than 30°C. CHILD and BELLAMY (1920) reported that a sudden rise of temperature from 15° to 20°C. in the saturated air usually induced outgrowth of some roots on the attached leaves of *B. calycinum*, but the development of these regenerated roots was soon inhibited.

## 2. *Intramolecular Respiration*

The potted plants were closed in a bell jar, filled with hydrogen-gas, for 48–72 hours in the laboratory. The temperature was about 20°C. In hydrogen-gas, any other remarkable changes were not recognized in the plant body, except the loss of brilliancy of the leaves. But this symptom was of small duration after the treatment. Plants

thus treated were placed in a room, where no gas burner was used, and people seldom came in, the sunny illustration was good, and the temperature was kept between 15° and 24°C.   They were covered with bell jars and given a full supply of fresh air.   About 2 weeks later, the regenerated roots appeared at the notches of the leaves of the treated plants, not long afterwards the production of shoots had occurred chiefly on the leaves of the middle and lower level of the stem (Fig. 2).



Fig. 2

Sometimes adventive roots appeared in the lower part of the stem. The same results were attained by keeping the treated leaves with their apices in water (Fig. 3).   The control plants did not show such a result.

### 3. *Injection with Chemicals*

Basing upon BORESCH's experimental results, which are stated in the preceding pages, some chemicals, such as aceton, acetaldehyde, ethyl alcohol, and pyruvic acid, which are after NEUBERG the end and intermediate products of alcoholic fermentation, were used for the injection. Each chemical was prepared in concentration of 0.5, 0.05 and 0.01%. About 0.3–1 cc. of them were injected into the stem, the petioles, or leaf margin near the notch of the different individuals. One group of the plants was injected once only, and the other group had



Fig. 3

repeated injections once every day continuously over 5 days. As the control, water injections were carried out. Many of the experiments of this series were not successful, but the results, which were obtained in September and October 1927, were worth while to notice and they are shown in the following table:

## TABLE I

0.5% solutions of each chemical were injected into petioles once a day for 5 days. This experiment was worked out in the greenhouse. Sept. 29—Oct, 20, 1927.

| | Aceton | Acetaldehyde | Ethylalcohol | Pyruvic acid | Control |
|---|---|---|---|---|---|
| Regeneration | — | +<br>(roots) | — | +<br>(tiny shoots) | — |

## TABLE II

0.05% solutions of each chemical were injected into petioles of young plants only once. This experiment was worked out in the moist chamber in the greenhouse. Oct. 19—30, 1927.

| | Aceton | Acetaldehyde | Ethylalcohol | Pyruvic acid | Control |
|---|---|---|---|---|---|
| Regeneration | — | +<br>(roots) | — | +<br>(roots) | — |

By introducing BORESCH's result of his analytical experiment on bud-forcing action in the warm bath method, it would be easily understood, why the regeneration occurs in the attached leaves of *Bryophyllum calycinum*. That is to say, some chemical substances, which were formed in such an occasion, stimulate the cell division for the regeneration. These chemicals might be identical with some of the intermediate products of alcoholic fermentation, or if not, might be some of the related substances. These kinds of substances could be produced by absolute isolation, physiological isolation, or ringing etc., assuming that the superfluous accumulation of the assimilated substance causes such an abnormal metabolism, as that which occurs in the case of intramolecular respiration. This is very probable especially in the case of *Bryophyllum*, which belongs to the succulent, and whose carbohydrate assimilation and respiration usually deviate to some extent from those of common plants. That old *Bryophyllum* plants form sometimes tiny shoots on the attached leaves, as LOEB described, also may be explained in the same manner.

The writer therefore, supposes that the causes of cell division in the case of regeneration of *Bryophyllum* and the nutrient effect on the further development of the regenerated plants are of different kinds. Furthermore, from above-mentioned results it seems most probable that the regeneration in *Bryophyllum calycinum* is related with the formation or accumulation of some chemical substances.

In conclusion, the writer expresses his cordial thanks to Prof. SAKAMURA for his valuable suggestions and criticisms during this work, and also to Honorary Prof. MIYABE for his kindness in allowing him to use his library.

## Summary

1.  The warm bath and the intramolecular respiration cause the formation of roots and shoots in the attached leaves of *Bryophyllum calycinum*. The injection of some of the substances, which are assumed to be the intermediate products of alcoholic fermention, bring about the same effect.

2.  In isolated leaves of *Bryophyllum calycinum*, it is not improbable to assume that the formation or accumulation of some substances occurs, which are similar to the intermediate products of alcoholic fermentation, and they cause the regeneration.

December, 1927.

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Soon after the completion of this manuscript, the writer had the opportunity to read OSSENBECK's recent paper (Flora Bd. **122**, 1927) on the regeneration in *Bryophyllum*, which could not be consulted more in detail for the present work. However, it is only necessary to cite, that the warm bath method produced a negative result for the regeneration in *Bryophyllum* according to OSSENBECK's paper.

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# Über die vitale Oxydation der Pflanzenzellen mit den Kobaltamminkomplexsalzen

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Mit Tafel VIII–X und 9 Textfiguren

## I.  Einleitung

Zum Zweck der physiologischen Untersuchung der Zellen im lebenden Zustand verwendet man heutzutage eine Reihe von sogenannten vitalen Reaktionen, d.h. die vitale Färbung[1], vitale Präzipitation[2], vitale Reduktion[3] und vitale Oxydation.

Was speziell die zuletzt genannte Reaktion anbelangt, so hat W. PFEFFER[4] zuerst mit einer verdünnten Lösung von Wasserstoffsuperoxyd (1-0.01%) bei einigen wenigen Objekten, d.h. *Vicia faba*, *Trianea bogotensis*, *Tradescantia virginica*, *Hydrocharis morsus ranae*, *Atriplex hortense*, *Coleus spec.* und *Phlox paniculata* gute Resultate gewonnen.

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(1)  W. PFEFFER:  Unters. a. d. botan. Inst. Tübingen., **2** (1889), 179 ; P. EHRLICH :  Biolog. Centralbl., **6** (1886), 214 ; und zahlreiche neuere Arbeiten.

(2)  C. DARWIN :  Journ. Linn. Soc., Bot., **19** (1882), 239 ; T. BOKORNY : Jahrb. f. wiss. Bot., **18** (1887), 194 ; **19** (1888), 206 ; **20** (1889), 427 ; Ber. d. deut. bot. Ges., **8** (1890), 101 ;  O. LOEW u. T. BOKORNY :  Botan. Zeit., **52** (1887), 849 ;  Botan. Centralbl., **38** (1889), 581 ; **39** (1889), 369 ; **40** (1889), 161 ;  Flora, **76** (1892), 117 ;  P. KLEMM :  Flora, **75** (1892), 413 ;  Ber. d. deut. bot. Ges., **10** (1892), 237 ;  F. CZAPEK : Ber. d. deut. bot. Ges., **28** (1910), 147.

(3)  E. R. BECKER :  Biol Bull., **50** (1926), 235.

(4)  W. PFEFFER :  Abh. d. math.-phys. Kl. d. K. Sächs. Ges. d. Wiss., **15** (1889), 375.

Später im Jahre 1917 hat A. SPERLICH[1] gefunden, dass freies Jod in sehr kleinen Mengen in die lebende Pflanzenzelle einzudringen vermag und die Oxydation der im Zellsafte gelösten Gerbstoffe zu phlobaphenenartigen Produkten veranlasst, aber diese Reaktion kann kaum für eine vitale gelten, weil die Schnitte zuvor mit Alkohol behandelt werden müssen, wo sie zur mikroskopischen Beobachtung kommen.

K. NOACK[2] verwendete dann die unter der Lichtwirkung stehende verdünnte Lösung von den fluoreszierenden Farbstoffen (0.1% Eosin, 0.0015% Methylenblau u.a.) als das Reagens der vitalen Oxydation bei den Zellen von *Vicia faba*, *Aloe succotrina* etc. Die hiermit erzielte Reaktion scheint noch weniger ausgeprägt zu sein als mit Wasserstoffsuperoxyd.

Schon im Jahre 1918 haben Keita SHIBATA und Yuji SHIBATA[3] gefunden, dass gewisse Komplexsalze von Co, Ni u. Cu in sehr geringen Mengen eine phenolaseartige oxydierende Wirkung auf verschiedene Derivate von Polyphenolen ausüben. Auf Grund dieser Tatsache hat K. SHIBATA[4] eine neue Methode der vitalen Oxydation mit Erfolg ausgearbeitet.

Von meinem verehrten Lehrer, Herrn Professor Keita SHIBATA, wurde mir nun die Aufgabe gestellt, seine Beobachtung über die vitale Oxydation mittelst Kobaltamminkomplexsalze weiter auszubauen und deren physiologische Einflüsse auf die lebenden Pflanzenzellen einigermassen klarzulegen.

## II. Eigenschaften der angewandten Reagentien

Nach der oben erwähnten Arbeit von K. SHIBATA und Y. SHIBATA[5] lassen sich die Metallamminkomplexsalze bezüglich ihres Oxydationsvermögens in vier Gruppen einordnen. Ich habe zunächst folgende

(1) A. SPERLICH: Sitzungsber. Ksl. Akad. Wiss. Wien., math.-nat. Kl, **126** (1917), 103.
(2) K. NOACK: Zeit. f. Bot., **12** (1920), 273.
(3) K. SHIBATA u. Y. SHIBATA: Journ. Chem. Soc. Japan, **39** (1918), 980 (Japanisch); **41** (1920), 35 (Japanisch).
(4) K. SHIBATA: Bot. Magaz. Tokyo, **34** (1920), 36 (Japanisch); Toyo Gakugei Zasshi, **38** (1921), 17 (Japanisch).
(5) K. SHIBATA u. Y. SHIBATA: loc. cit.

dreiundzwanzig Kobaltkomplexsalze in 1/100 Mol wässriger Lösung als
das Reagens für die vitale Oxydation der Pflanzenzellen, und zwar
derselben aus den Gewebeschnitten des Blütenschaftes von *Musa
Basjoo* und des Perikarps von *Musa sapientum*, geprüft und gefunden,
dass die meisten von diesen Salzen beinahe gleichartige Oxydationser-
scheinungen hervorrufen, obgleich sich die Zeitdauer, die zum Eintreten
der sichtbaren Reaktion notwendig ist, augenscheinlich verschieden
zeigt. (Tab. I, S. 41).

Deswegen habe ich mich in vorliegender Arbeit nur mit
einer Verbindung, d.h. Chloropentamminkobaltichlorid (Purpureosalz),
$[Co(NH_3)_5Cl]Cl_2$, näher beschäftigt. Dieses hat ein mittelstarkes
Oxydationsvermögen und ist beständig in der wässrigen Lösung bei
Zimmertemperatur. Es löst sich in Wasser bis zu einer Konzentra-
tion von etwa 1/50 Mol auf und zeigt dann eine schöne purpurne Farbe.

Wie schon von Keita SHIBATA und Yuji SHIBATA nachgewiesen,
fallen die Phenolderivate mit zwei oder mehr, ortho- oder paraständ-
digen Hydroxylen, wie z. B. Brenzcatechin, Hydrochinon, Pyrogallol,
Quercetin, Myricetin u.s.w., der Oxydation durch Metallammine
anheim, die somit in ihrer Wirkung viel Analogie mit Phenolase
(Laccase) darbieten. Die Tabelle II veranschaulicht das besagte
Sachverhältnis.

Die von K. u. Y. SHIBATA entwickelte Theorie des Oxydations-
mechanismus von Metallamminen lautet etwa wie folgt[1]: Die oxydier-
baren Substanzen (Phenolderivate) werden zunächst irgendwie in die
Komplexkerne hineinbezogen und mit den ebenfalls dorthin gelangen-
den ,,aktivierten''[2] Wassermolekülen in engerer Berührung gebracht.
(Dafür spricht auch die Tatsache, dass bei dieser oxydativen Reaktion
Ammoniak aus den Koordinationsstellungen in Amminkomplexen
verdrängt wird, wie es unten näher gezeigt werden soll.) Die oxyda-
tive Wirkung der ,,aktivierten'' Wassermoleküle verläuft dann folgen-
dermassen, indem der Luftsauerstoff bloss als ein Wasserstoffacceptor
fungiert:

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(1) K. SHIBATA u. Y. SHIBATA: loc. cit.
(2) D.h. deassozierte.

$$R\diagdown\!\!\!\!\!\!{}^{OH}_{OH} \;+\; 2\,H.OH \;+\; O_2 \;=\; R\diagdown\!\!\!\!\!\!{}^{OH}_{OH}{}^{OH}_{OH} \;+\; H_2O_2 \;;$$

o- od p-Polyoxyphenole     Aktiviertes Wassermolekül

$$R\diagdown\!\!\!\!\!\!{}^{OH}_{OH}{}^{OH}_{OH} \;=\; R\diagdown\!\!\!\!\!\!{}^{O}_{O} \;+\; 2\,H_2O \;;$$

Chinonkörper

$$2\,H_2O_2 \;=\; 2\,H_2O \;+\; O_2 \;.$$
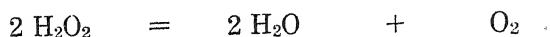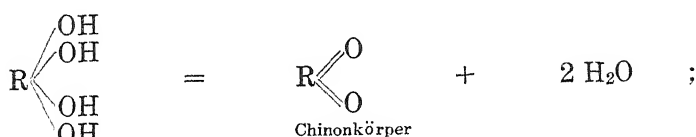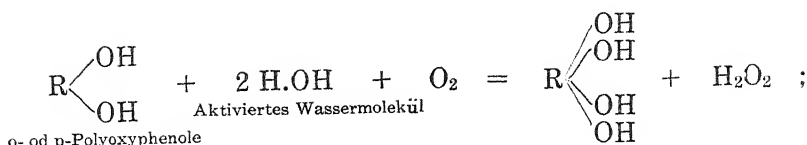
Die anfänglich entstehenden chinonartigen Körper werden bald in gefärbte und z. T. schwerlösliche Kondensationsprodukte umgewandelt.

Die oxydative Wirkung der Metallammine auf Polyphenole wird in saurem Medium verzögert und in alkalischem beschleunigt.[1] Um diese Tatsache zu bestätigen, wurde die Reaktion in Puffergemischen, bestehend aus $KH_2PO_4$ und KOH und aus $HBO_3$, KCl und KOH, welche nach CLARK und LUBS[2] bereitet wurden, vorgenommen; die Verschiedenheit in der stofflichen Zusammensetzung dieser beiden Gemischen war ohne merklichen Einfluss auf die Endresultate. Zu einer Reihe von Puffer-Lösungen (10 ccm) wurden gleiche Mengen (10 ccm) von der Lösung der oxydierbaren Substanzen (Gerbstoff von *Spirogyra*[3] in 1%-iger wässriger Lösung; Myricetin, Quercetin und Myricitrin in 1%-igen Lösungen in 50%-igem Alkohol) hinzugefügt, und sogleich wurden ihre pH-Werte elektrometrisch mit Hilfe der Chinhydronelektrode bestimmt. 10 ccm dieser Lösungen wurden dann mit je 2 ccm von 0.4%-iger Chloropentamminkobaltichloridlösung gemischt. Die Reaktionszeit, d.h. die bis zum Eintreten des bestimmten Reaktionsgrades (Oxydationsfärbung) verstrichene Zeitdauer, wurde genau notiert und in der Tabelle III und Figur 1 angegeben. Zum Vergleich

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(1)   K. SHIBATA u. Y. SHIBATA: loc. cit.

(2)   W. M. CLARK: The Determination of Hydrogen Ions, (1925), 99.

(3)   C. van WISSELINGH: Beih. z. bot. Centralbl., **32** (1914), 158.

## Tabelle I

Zeitdauer (in Sekunden) bis zum Zustandekommen der vitalen Oxydation

| Substanz | Parenchymzellen aus | |
|---|---|---|
| | *Musa Basjoo* | *Musa sapientum* |
| $[Co(NH_3)_3(NO_3)_3]$ | 15 | 15 |
| $[Co(NH_3)_5Cl](NO_3)_2$ | 35 | 20 |
| $[Co(NH_3)_4H_2OCl]Cl_2$ | 35 | 25 |
| $[Co(NH_3)_5Cl]Cl_2$ | 45 | 30 |
| $[Co(NH_3)_4CO_3]NO_3 \cdot 1/2 \cdot H_2O$ | 60 | 75 |
| $[Co(NH_3)_5NO_3]Br_2$ | 65 | 50 |
| $[Co(NH_3)_5H_2O]Cl_3$ | 75 | 50 |
| $[Co(NH_3)_4(H_2O)_2]_2(SO_4)_3 \cdot 3H_2O$ | 75 | 55 |
| $[Co(NH_3)_5NO_3](NO_3)_2$ | 90 | 60 |
| $[Co(NH_3)_5SCN]Cl_2$ | 105 | 135 |
| $[Co(NH_3)_5Cl]C_2O_4$ | 120 | 1080 |
| $[Co(NH_3)_3(NO_2)_3]$ | 135 | 180 |
| $[Co(NH_3)_5NO_2]Cl_2$ | 135 | 90 |
| $[Co(NH_3)_5H_2O]_2(C_2O_4)_3 \cdot 4H_2O$ | 180 | 165 |
| $[Co(NH_3)_4CO_3]_2SO_4 \cdot 3H_2O$ | 180 | 270 |
| $[Co(NH_3)_4(NO_2)_2]NO_3$ | 180 | 630 |
| $[Co(NH_3)_2(NO_2)_4]NH_4$ | 225 | 720 |
| $[Co(NH_3)_5ONO]Cl_2$ | 270 | 405 |
| $[Co(NH_3)_2(NO_2)_2C_2O_4]NH_4 \cdot H_2O$ | 315 | 315 |
| $[Co(NH_3)_4(NO_2)_2]Cl$ | 630 | 900 |
| $[Co(NH_3)_6](NO_3)_3$ | 1080 | 1350 |
| $[Co(NH_3)_6]Cl_3$ | ∞ | ∞ |
| $[Co(NH_3)_5Cl]_2(HSO_4)_2SO_4$ | ∞ | ∞ |

## Tabelle II

Oxydation durch Chloropentamminkobaltichlorid

| Stoff | Formel | Oxydation |
|---|---|---|
| Phenol | $C_6H_5.OH$ | − |
| Brenzcatechin | $C_6H_4\big\langle \begin{smallmatrix} OH\,(1) \\ OH\,(2) \end{smallmatrix}$ | + |
| Resorcin | $C_6H_4\big\langle \begin{smallmatrix} OH\,(1) \\ OH\,(3) \end{smallmatrix}$ | − |
| Hydrochinon | $C_6H_4\big\langle \begin{smallmatrix} OH\,(1) \\ OH\,(4) \end{smallmatrix}$ | + |
| Salicylaldehyd | $C_6H_4\big\langle \begin{smallmatrix} OH\,(1) \\ CHO\,(2) \end{smallmatrix}$ | − |

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## TABELLE II (*Fortsetzung*)
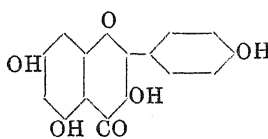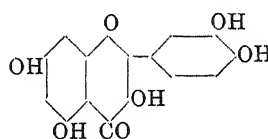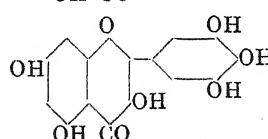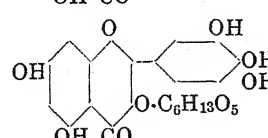
| Stoff | Formel | Oxydation |
|---|---|---|
| Guajakol | $C_6H_4{<}^{OCH_3\ (1)}_{OH\ (2)}$ | -- |
| Tyrosin | $C_6H_4{<}^{OH\ (1)}_{CH_2{\cdot}CH(NH_2)COOH\ (4)}$ | — |
| Pyrogallol | $C_6H_3{<}^{OH\ (1)}_{OH\ (3)}$ mit OH (2) | + |
| Phloroglucin | $C_6H_3{<}^{OH\ (1)}_{OH\ (5)}$ mit OH (3) | -- |
| Oxyhydrochinon | $C_6H_3{<}^{OH\ (1)}_{OH\ (4)}$ mit OH (2) | + |
| Orcin | $C_6H_3{<}^{CH_3\ (1)}_{OH\ (5)}$ mit OH (3) | — |
| Thymol | $C_6H_3{<}^{CH_3\ (1)}_{OH\ (3)}$ mit $C_3H_7$ (4) | — |
| Kämpferol | (Strukturformel: Flavon mit OH-Gruppen) | — |
| Quercetin | (Strukturformel) | + |
| Myricetin | (Strukturformel) | + |
| Myricitrin | (Strukturformel mit $O{\cdot}C_6H_{13}O_5$) | + |
| Gallussäure | $C_6H_2{<}^{(OH)\ (3,\ 4,\ 5)}_{COOH\ (1)}$ | + |
| Gallusgerbsäure (Tannin) | | + |
| Paraphenylendiamin | $C_6H_4{<}^{NH_2\ (1)}_{NH_2\ (4)}$ | + |
| Benzidin | $H_2N{\cdot}C_6H_4{\cdot}C_6H_4{\cdot}NH_2$ | — |

## Tabelle III

Der Einfluss der H-Ionenkonzentration und der Puffer auf die oxydative
Wirkung von Chloropentamminkobaltichlorid

| pH-Wert | Reaktionszeit (in Minuten) | | | | | |
| | Gepufferte Lösung | | | | Pufferarme Lösung | |
| | Myricetin | Quercetin | Myricitrin | Gerbstoff von *Spirogyra* | Myricitrin | Gerbstoff von *Spirogyra* |
|---|---|---|---|---|---|---|
| 3.6 | >400 | | | >400 | | |
| 4.3 | >400 | | | | | |
| 4.6 | | | >400 | >400 | | |
| 5.0 | | >400 | | | | 10 |
| 5.2 | >400 | | | | | |
| 5.5 | | | | | 75 | |
| 5.7 | | | | >400 | | |
| 5.8 | >400 | >400 | >400 | | | |
| 6.1 | | | | | | 7 |
| 6.2 | 200 | | | 240 | | |
| 6.3 | | | | | 20 | |
| 6.7 | 10 | >400 | | 50 | | |
| 6.9 | | | >400 | | | 3 |
| 7.3 | 3 | | | 20 | | |
| 7.4 | | 170 | 230 | | 14 | |
| 7.7 | 1 | | | 8 | | |
| 7.8 | | | 55 | | | |
| 7.9 | | 10 | | | | |
| 8.1 | | | 35 | | | |
| 8.2 | | 3 | | | | |
| 8.4 | 0.5 | | | | | |
| 8.7 | | | 15 | 4 | | |
| 9.2 | | 1 | | | | |
| 9.5 | | | | 1.5 | | |
| 9.6 | | | 5 | | | |
| 9.8 | | 0.5 | | | | |

wurde eine entsprechende Versuchsreihe mit pufferarmen Lösungen
angestellt. Als solche Lösungsmittel benutzte ich destilliertes Wasser
(pH 5.5), Leitungswasser (pH 7.5) und aus beiden hergestellte Wasser-
gemische (pH 6-7); weitere Behandlung ist wie bei oben erwähnten.

Aus der Tabelle III und Figur 1 ersieht man, dass in allen Fällen die Oxydation an der sauren Seite mehr verlangsamt und an der alkalischen stark beschleunigt wird, und ferner, dass bei derselben Anfangsacidität die Reaktion bedeutend später in den gepufferten Lösungen als in den pufferarmen eintritt. Diese letztere Tatsache erklärt sich zum Teil aus dem Umstand, dass bei eintretender oxydativer Reaktion Ammoniak aus Amminkomplexen freigemacht wird und demzufolge
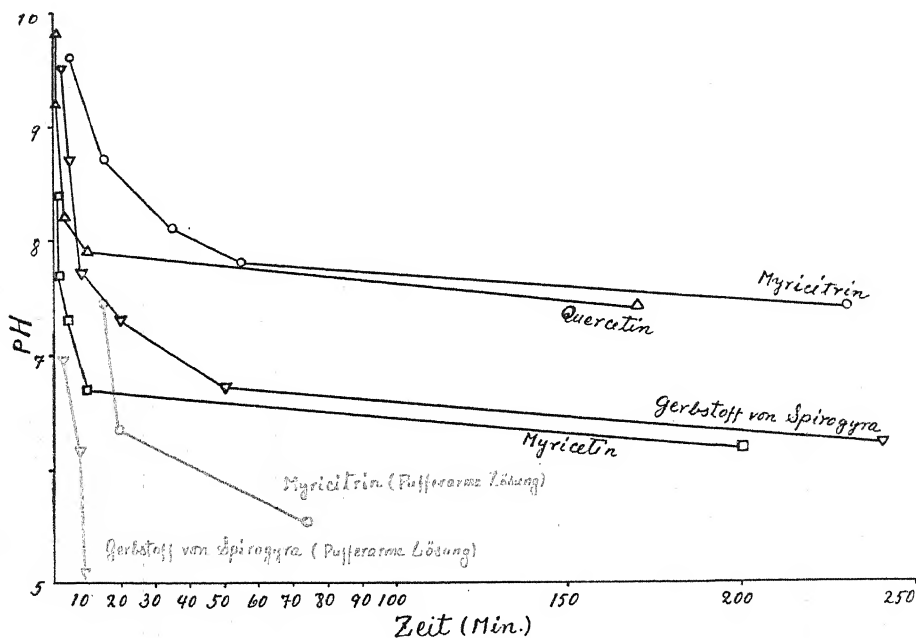


Fig. 1

der pH-Wert der pufferarmen Lösungen ansteigt. Jedenfalls ist die Abhängigkeit der Oxydation von der H-Ionenkonzentration und von der Pufferwirkung der bestimmende Moment auch für das Zustandekommen und den zeitlichen Verlauf der vitalen Reaktion in den Zellen, wie ich unten näher zeigen werde.

Wie schon erwähnt, werden Ammoniak-Moleküle aus Chloropentamminkobaltichlorid freigemacht, sobald das letztere die oxydierbaren Substanzen angreift. Obwohl die Menge des auftretenden Ammoniaks freilich sehr gering ist, konnte ich es mit Hilfe des in Figur 2 gezeichneten Apparates sehr deutlich nachweisen. Ein mit Eiswasser auf

0°C. gekühltes Röhrchen enthält Leitungswasser (pH 7.5), das mit Thymolblau gefärbt ist (A). Die Lösungen von der oxydierbaren Substanz, z. B. Myricetin, und vom Chloropentamminkobaltichlorid werden in Röhrchen C bezw. D hineingetan. Nachdem der pH-
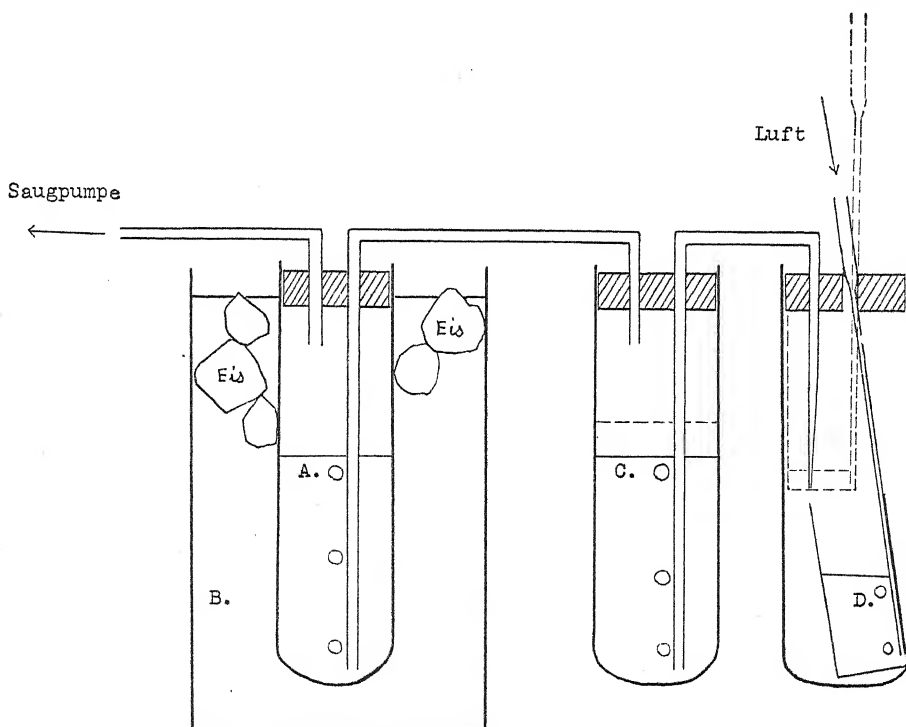


Fig. 2

A—5 ccm von Leitungswasser (pH 7.5), das mit Thymolblau gefärbt wurde.
B—Eiswasser (0°C.).
C—5 ccm der 0.005% Lösung der oxydierbaren Substanz.
D—1 ccm der 0.4% Lösung des Chloropentamminkobaltichlorids.

Wert von A sowohl als auch die Farbe von C beim Hindurchleiten der Luft während 10 Minuten unveränderlich blieb, liess man die Chloropentamminkobaltichloridlösung nach C hinübertreten, indem das Röhrchen D in eine mit der gestrichelten Linie bezeichnete Lage gebracht wird. In der so hergestellten Mischung zweier Lösungen kommt die Oxydationserscheinung nach kurzer Zeit zu stande. Das in diesem Augenblick freigemachtes Ammoniak wird durch Luftstrom nach A getrieben, und dort die Farbenveränderung von Thymolblau

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## TABELLE IV

Freiwerden des Ammoniaks aus Chloropentamminkobaltichlorid
bei der oxydativen Reaktion

| Oxydierbare Substanz | pH-Wert der Indikatorlösung (A) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | Nach 1 Min. | ,, 2 ,, | ,, 3 ,, | ,, 4 ,, | ,, 5 ,, | ,, 6 ,, | ,, 7 ,, | ,, 8 ,, | ,, 9 ,, | ,, 10 ,, | ,, 11 ,, | ,, 1 ,, | ,, 13 ,, |
| Myricetin | 7.5 | 8.2 | 8.8 | 9.2 | 9.4 | — | — | 9.6 | — | — | — | — | — | 9.8 |
| Quercetin | 7.5 | 7.5 | — | — | 8.2 | 8.4 | 8.7 | — | 9.1 | — | 9.3 | — | — | 9.6 |
| Myricitrin | 7.5 | 7.5 | 7.5 | — | 8.0 | 8.2 | — | 8.4 | 8.6 | 8.8 | 9.0 | 9.2 | — | 9.5 |
| Gerbstoff von *Spirogyra* | 7.5 | 7.5 | 8.2 | 8.4 | — | 8.6 | — | 8.7 | — | 8.8 | — | — | — | 9.1 |
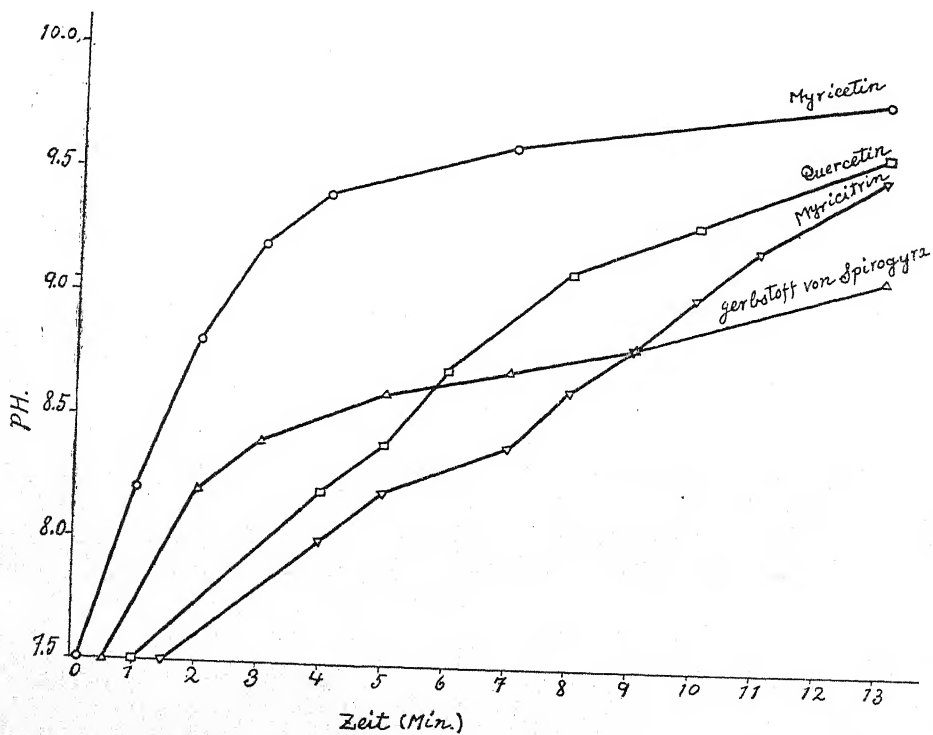


Fig. 3

verursacht, wobei die pH-Verschiebung kolorimetrisch leicht zu verfolgen ist. Die erhaltenen Resultate werden in Tabelle IV und Figur 3 angegeben. Bringt man Nesslersches Reagens statt der Indikatorlösung in A hinein, so entsteht etwa nach 10 Minuten die charakteristische hellbraune Fällung. Erwärmt man die Mischung von Chloropentamminkobaltichlorid und Myricetin auf 80°C., so gelingt der Nachweis von Ammoniak sehr leicht. Das frei gewordene Ammoniak verschiebt die Acidität des Reaktionsgemisches nach der alkalischen Seite und bedingt dadurch das autokatalytische Ansteigen der Oxydationsgeschwindigkeit.

## III. Über die Permierbarkeit der Metallkomplexsalze in die lebenden Zellen

Obzwar das Zustandekommen der vitalen Oxydation die Permierbarkeit der Komplexsalze (Kationen) in die lebenden Zellen voraussetzt, so hat man doch bei der quantitativen Ermittelung der Intrapermeabilität mit einiger Schwierigkeiten zu kämpfen. Da die Wasserlöslichkeit der Komplexsalze verhältnismässig gering (bis 0.02 Mol) ist, so sind hierbei weder die bekannten plasmolytischen Methoden (Lepeschkin,[1] Tröndle[2] und Fitting)[3] noch die plasmometrische Methode (Höfler)[4] gut anwendbar. Ich verfuhr daher folgendermassen : Blattepidermiszellen von *Rhoeo discolor* wurden in einer noch hypotonischen Lösung von Rohrzucker (0.2 Mol), welcher Chloropentamminkobaltichlorid in verschiedenen kleinen Konzentrationen hinzugefügt ist, eingelegt, und der Prozentsatz der Zellen in grenzplasmolytischem Zustand wurde in bestimmter Zeitintervalle ermittelt. In schwach hypertonischen Lösungen erreichte diese Zahl ihren höchsten Betrag etwa nach einer Stunde, gemäss der alten Beobachtung von de Vries,[5] aber sie nahm innerhalb weiterer drei Stunden allmählig ab, wie in der Tab. V und Fig. 4 gezeigt. Diese letztere Tatsache deutet auf eine Deplasmolyse infolge der Endosmose des Komplexsalzes hin. Erkennt man diesen Schluss als richtig an, so kann man doch nicht die Intrapermeabilität des Komplexsalzes hoch

(1)  W. W. Lepeschkin :  Ber. deut. bot. Ges., **26** (1908), 198, 239.
(2)  A. Tröndle :  Jahrb. f. wiss. Bot., **48** (1910), 171.
(3)  H. Fitting :  Jahrb. f. wiss. Bot. **56**, (1915), 1 ; **57** (1917), 553.
(4)  K. Höfler :  Ber. d. deutsch. bot. Ges., **36** (1918), 414.
(5)  H. de Vries :  Jahrb. f. wiss. Bot., **14** (1884), 444.

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## TABELLE V

Prozentsatz der plasmolysierten Zellen in hypertonischen Mischlösungen von
Rohrzucker und Chloropentamminkobaltichlorid
Material—Epidermiszellen der Blattunterseite von *Rhoeo discolor*
Temperatur—25°C.

| Konzentration (Mol) | | Plasmolysierte Zellen (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Rohrzucker | Chloropentammin-kobaltichlorid | Nach 10 Min. | ,, 30 ,, | ,, 50 ,, | ,, 70 ,, | ,, 90 ,, | ,, 120 ,, | ,, 200 ,, | ,, 250 ,, |
| 0.2 | 0.002 | — | — | — | — | — | — | — | — |
| 0.2 | 0.004 | — | — | — | — | — | — | — | — |
| 0.2 | 0.006 | — | 15 | 57 | 65 | 64 | 52 | 48 | 41 |
| 0.2 | 0.008 | 3 | 30 | 80 | 87 | 89 | 82 | 74 | 73 |
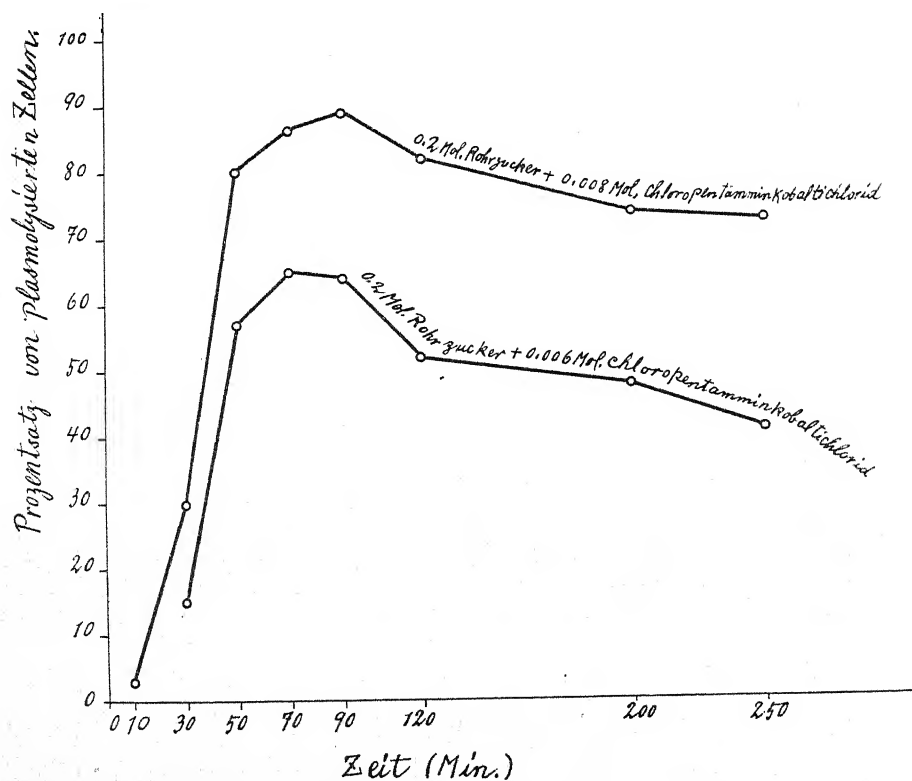


Fig. 4

anschätzen. Hierbei muss man aber den Umstand in Betracht ziehen, dass gerade die Epidermiszellen von *Rhoeo* keine merkliche vitale Oxydationserscheinung, wenigstens innerhalb 18 Stunden, zeigten. In anderen Zellen mit leicht oxydierbaren Einschlüssen könnte eine noch ausgiebigere Endosmose schon deshalb stattfinden, dass eindringende Komplexsalze fortwährend in den Zellen umgesetzt werden.

## IV. Vorgänge der vitalen Oxydation

Die mit dem Rasiermesser hergestellten Schnitte der Pflanzengewebe werden während einigen Minuten mit destilliertem Wasser abgespült und auf dem Objektträger in einem Tropfen verdünnter Chloropentamminkobaltichloridlösung montiert. Unter dem Mikroskop kann man dann die durch Oxydation verursachten Veränderungen in den Zellen genau beobachten.

Die Oxydation des Zellinhaltes wird gewöhnlich schon nach einigen Minuten durch die Veränderungen von Farben sehr deutlich angezeigt und darauf folgt öfters die Entstehung von feineren oder gröberen Fällungen in den Zellen.

### (a) *Der zeitliche Verlauf der intrazellularen Reaktion*

Die Reaktionszeit, d.h. die zum Zustandekommen der intrazellularen Oxydationserscheinungen notwendige Zeitdauer, hängt von den äusseren und inneren Bedingungen ab; die ersteren sind die oxydative Wirksamkeit (vergl. Tab. I), Konzentration und Permierbarkeit der angewandten Komplexsalze, Temperatur u.s.w., und die letzteren sind vor allem der Gehalt der Zellen an oxydierbaren Substanzen, der pH-Wert und die Pufferwirkung der Protoplasten und Zellsäfte. Der Zusammenhang zwischen Reaktionszeit und Salzkonzentration habe ich bei einem besonders langsam reagierenden Objekt, *Spirogyra setiformis*,[1] näher untersucht (Tab. VI. u. Fig. 5).

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(1) Nach mündlicher Mitteilung von Herrn Prof. K. SHIBATA reagierten verschiedene, früher von ihm untersuchten *Spirogyra*arten noch viel schneller.

A. WATANABE

## TABELLE VI

Vitale Oxydation von *Spirogyra setiformis* mit verschieden konzentrierten
Chloropentamminkobaltichloridlösungen
Temp.  20°C.

| Konzentration | Prozentsatz der oxydierten Zellen | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Nach 30 Minuten | ,, 60 ,, | ,, 90 ,, | ,, 120 ,, | ,, 150 ,, | ,, 180 ,, | ,, 210 ,, | ,, 240 ,, | ,, 19 Stunden | ,, 45 ,, | ,, 6 Tagen |
| 1/50 Mol | — | 5 | 14 | 46 | 61 | 83 | 92 | 68 | 100 | 99 | 100 |
| 1/100 ,, | — | — | 3 | 22 | 42 | 44 | 57 | 61 | 99 | 100 | 100 |
| 1/500 ,, | — | — | — | — | — | 2 | 11 | 28 | 32 | 91 | 98 |
| 1/1000 ,, | — | — | — | — | — | — | — | — | — | 20 | 91 |
| 1/5000 ,, | — | — | — | — | — | — | — | — | — | 6 | 63 |
| 1/10000 ,, | — | — | — | — | — | — | — | — | — | — | 14 |
| 1/50000 ,, | — | — | — | — | — | — | — | — | — | — | 4 |
| 1/100000 ,, | — | — | — | — | — | — | — | — | — | — | -- |
| 1/500000 ,, | — | — | — | — | — | — | — | — | — | — | — |
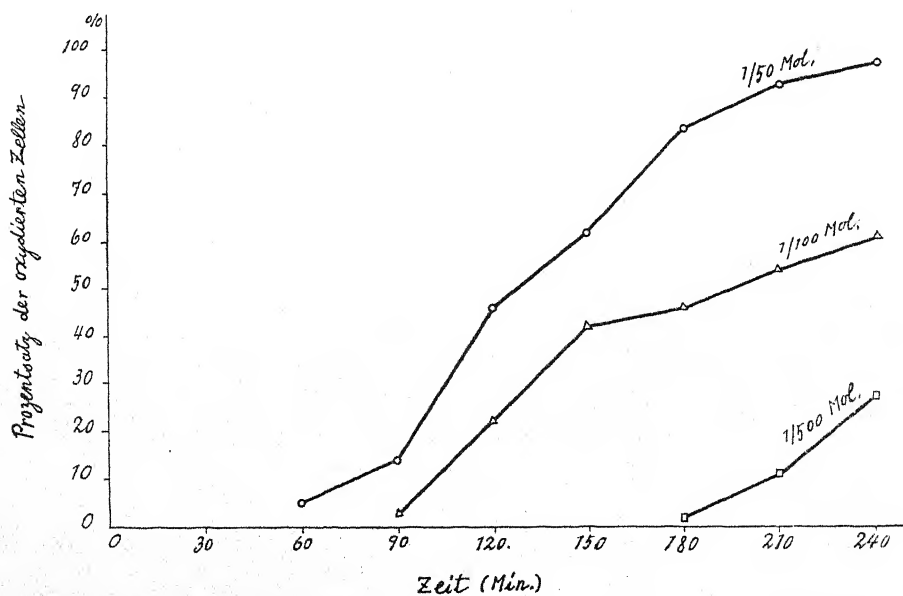


Fig. 5

Was den Einfluss der Temperatur anbelangt, so beschleunigt die höhere Temperatur im allgemeinen die vitale Oxydation, wie es aus der Tab. VII und Fig. 6 ersichtlich ist. Die plötzliche Zunahme des Prozentsatzes der oxydierten Zellen bei 40°C. beruht aber wahrscheinlich auf die schon bei dieser Temperatur eintretende Beschädigung der lebenden Protoplasten.

Behandelt man die Zellen der verschiedenen Pflanzen mit demselben Komplexsalz, so variiert die Reaktionsdauer gewöhnlich innerhalb ein paar bis zehn Minuten. Dieser Unterschied kommt erstens aus der chemischen Natur der vorhandenen oxydierbaren Substanzen, und zweitens aus den Differenzen in pH-Wert und Pufferwirkung des Zellinhaltes zu stande, wie es aus den in der Tab. III und Fig. 1 dargestellten Versuchsergebnissen *in vitro* leicht zu erkennen ist.

Nach neueren Feststellungen, z.B. von ROHDE,[1] ATKINS,[2] HOAGLAND und DAVIS,[3] GUSTAFSON,[4] PEARSALL und EWING,[5] NĚMEC,[6] TAYLOR,[7] u.a., liegen die pH-Werte des Zellsaftes in den

TABELLE VII

Der Einfluss der Temperatur auf die vitale Oxydation von *Spirogyra setiformis* mit 1/100 Mol Lösung von Chloropentamminkobaltichlorid

| Temperatur | Prozentsatz der oxydierten Zellen | | | | | |
|---|---|---|---|---|---|---|
| | Nach 30 Min. | ,, 60 ,, | ,, 120 ,, | ,, 180 ,, | ,, 240 ,, | ,, 300 ,, |
| 0°C. | — | — | 9 | 15 | 21 | 22 |
| 10°C. | — | 5 | 14 | 37 | 46 | 53 |
| 20°C. | — | 10 | 41 | 44 | 59 | 66 |
| 30°C. | 3 | 29 | 46 | 51 | 65 | 40 |
| 40°C. | 21 | 92 | 99 | 100 | 100 | 100 |

(1) K. ROHDE: PFLGEÜRS Archiv., **168** (1917), 411.
(2) R. G. ATKINS: Proc. Roy. Dublin Soc., **16** (1922), 414.
(3) D. I. HOAGLAND and A. R. DAVIS: Journ. Gen. Physiol., **5** (1923), 629.
(4) F. G. GUSTAFSON: Amer. Journ. of Bot., **11** (1924), 365.
(5) W. H. PEARSALL and J. EWING: Brit. Journ. of Exper. Biol., **2** (1925), 347.
(6) A. NĚMEC: C. R. Acad. Paris, **180** (1925), 1776.
(7) C. V. TAYLOR and D. M. WHITAKER: Protoplasma, **3** (1927), 1.

meisten Pflanzenzellen auf der sauren Seite. Aber dieser Aciditäts-
wert ist keine feststehende, sondern veränderlich im gewissen Umfang.
So z.B., nach ROHDE, PEARSALL und EWING u.a., schwankt der pH-
Wert von *Spirogyra*zellen zwischen 5 und 7, je nach Belichtungsver-
hältnissen u.s.w. Daraus erklären sich auch einige Unstimmigkeiten
in den Versuchsresultaten, die mit verschiedenem Zellenmaterial
gewonnen sind (vergl. die Zahlen bei der Versuchstemperatur 20°C.
in den Tab. VI und VII).
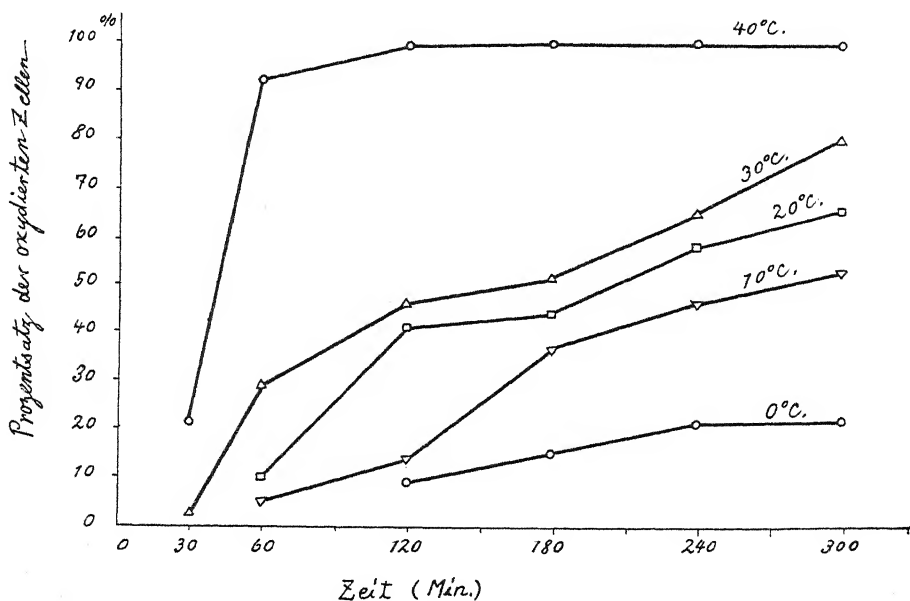


Fig. 6

(b) *Farbenveränderungen in den vitaloxydierten Zellen*

Die Farbenveränderungen, die durch die vitale Oxydation mit
Chloropentamminkobaltichlorid hervorgebracht werden, sind sehr
mannigfaltig. Ich habe diese Erscheinung bei den Blattepidermiszellen
von 355 Pflanzenarten näher beobachtet und gefunden, dass in sehr
vielen Fällen die Farbenveränderung in folgender Reihenfolge ge-
schieht: farblos—gelb—braun. Aber in einigen Pflanzen habe ich auch
Rot und Blau anstatt Gelb wahrgenommen. Darum kann man an-
nehmen, dass zuweilen schon durch die Kombination von diesen drei

Grundfarben alle möglichen Mischfarben zustande kommen. Tatsächlich habe ich in den Epidermiszellen durch vitale Oxydation sehr verschiedene Farben, wie grün, violett, orange u.s.w. entstehen gesehen. Aber diese Zwischenfarben sind nicht dauerhaft und schlagen durch die weitere Oxydation mehr oder minder schnell ins rotbraun oder schwarzbraun um.

Einige Beispiele seien hier erwähnt:—

Farblos....Gelb......Braun  (die meisten Pflanzenarten)

Farblos....Rot.......Braun  (z.B. *Primula modesta* BISS. et MOORE, *Rhus javanica* L.) (Taf. X, Fig. 1)

Farblos....Blau......Braun  (z.B. *Vicia sativa* L. var. *normalis* MAKINO) (Taf. X, Fig. 8)

Farblos....Orange...Braun  (z.B. *Erythroxylum Coca*, L., *Paphiopedilum Spicerianum* PFITZ.) (Taf. X, Fig. 2 u. 3)

Farblos....Violett....Braun  (z.B. *Sophora japonica* L., *Foeniculum vulgare* GAERTN.) (Taf. X, Fig. 12)

Farblos....Grün.....Braun  (z.B. *Vicia sativa* L. var. *normalis* MAKINO, *Pinguicula vulgaris* L.) (Taf. X, Fig. 8 u. 13)

Farblos............. Braun  (z.B. *Diospyros Kaki* L. — Fruchtfleisch)

Farblos...... Schwarzbraun  (z.B. *Rhus vernicifera* DC., *Liriope graminifoliä* BAK.) (Taf. X, Fig. 9 u. 10).

Der Sitz dieser Farbenveränderung ist in erster Linie die Safträume oder Vakuolen, in welchen die oxydierbaren Substanzen gelöst enthalten sind. In einigen Fällen erleiden aber die geformten Einschlüsse des Protoplasten, wie Fucosanblasen[1], gewisse Mikrosomen u.s.w., auch die oxydative Veränderung.

Was den Zellkern anbetrifft, so wird er in meisten Fällen, sogar in abgestorbenem Zustand, nicht sichtbar oxydativ verändert, aber in einigen wenigen Fällen (z.B. *Ebulus chinensis* NAKAI, *Foeniculum*

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(1) Von *Ecklonia cava* KJELLM. u. *Sargassum enerve* AG.

*vulgare* GAERTN. (Taf. X, Fig. 3), *Rhodea japonica* ROTH., *Laelia glauca* BENTH., *Picris hieracioides* L. var. *japonica* REGEL) habe ich stark gefärbte Kerne gesehen. Ob die so oxydierten Kerne noch lebendig oder schon tot sind, konnte ich leider nicht feststellen.

Die Chromatophoren, Stärkekörner, Aleurone, Oeltröpfchen, Schleime u.a. zeigen keine Farbenveränderung. Die Harze und ätherischen Oele, die öfters viel oxydierbare Substanzen enthalten, werden sehr deutlich gefärbt. Die Anthocyane in den Zellen werden unter Einwirkung von Kobaltpentamminchlorid entweder in kurzer Zeitfrist nicht verändert (z.B. Blumenblatt von *Canna indica* L. var. *orientalis* HOOK. f.) oder gänzlich entfärbt (z.B. *Gynura bicolor* DC.-Blattepidermis, *Yucca gloriosa* L. var. *recurvifolia* BAK.-Stammepidermis). Aber in dem Falle vom Blumenblatt von *Pelargonium inquinans* AIT., verändert sich das rote Anthocyan ins violett, und nach einiger Zeit entstehen viele Präzipitationen in den Zellen. Sehr oft zeigen die anthocyanhaltigen Zellen die blaue, grüne, braune oder schwarze Farbenveränderung (z.B. Blau:—*Begonia argento-guttata* hort., *Acalypha Wilkesiana* MUELL ARG.; Grün:—*Mimosa pudica* L., *Cornus controversa* HEMSL.; Gelb:—*Phytolacca esculenta* HOUTT. (Taf. X, Fig. 7), *Celosia cristata* L.; Braun u. Schwarz:—*Phytolacca esculenta* HOUTT. (Taf. X, Fig. 7), *Drosera longifolia* L. (Taf. X, Fig. 6). In solchen Fällen betrifft die Veränderung nicht immer die Anthocyane selbst, sondern andere coexistierende oxydierbare Substanzen.

Die leicht oxydierbaren Substanzen in den Pflanzenzellen sind, wie schon gesagt, verschiedene Phenolderivate, z.B. Flavonderivate, Gerbstoffe, Catechine u.s.w.. Aber es ist zur Zeit unmöglich, auf Grund der Oxydationsfärbungen die chemische Natur der betreffenden Inhaltstoffe zu erschliessen, zumal da sie häufig in Gemischen vorliegen.

### (c) *Aggregation und Präzipitation infolge der vitalen Oxydation*

Durch vitale Oxydation werden noch andere sichtbare Veränderungen in den Zellen hervorgerufen. In einigen Fällen zieht sich der ganze Plasmaschlauch zusammen, also ob er durch die hypertonische Lösung plasmolysiert war (z.B. *Trachelospermum asiaticum* NAKAI (Taf. VIII, Fig. 4), *Lactuca debilis* BENTH. et HOOK. f. (Taf. X, Fig. 11), *Brasenia Schreberi* GMEL. (Taf. IX, Fig. 4). Anscheinend ist das Plasma dabei in erstarrten Zustand geraten und lässt sich nicht „deplasmolysieren."

Bisweilen kommt ein sich an die sogenannte Aggregation erinnernder Vorgang zu stande, indem der stark gefärbte Saftraum in zahlreiche kugelige Gebilde zerteilt erscheint. Einige typische Fälle sind in Taf. IX, Fig. 1 (*Callicarpa japonica*-Blattepidermiszelle), Taf. VIII, Fig. 2 u. Taf. IX, Fig. 2 (*Aeginetia indica*-Stammepidermiszelle), Taf. X, Fig. 11 (*Lactuca debilis*-Blattepidermiszelle), Taf. X, Fig. 6 (*Drosera rotundifolia*-Tentakelzelle) abgebildet. Bei Blattepidermiszellen von *Primula modesta* BISS. et MOORE (Taf. XI, Fig. 1) beobachtet man zunächst die Entstehung von schwach gefärbten Kugeln im Cytoplasma, die sich allmählig stark bräunen.

Sehr häufig werden mehr oder minder feine Präzipitationen mit der Zeit im durch Oxydation einheitlich gefärbten Zellsaft erzeugt, und diese Präzipitationen treten zu Kugeln, Ballen oder Klümpchen von verschiedener Grösse zusammen (z.B. *Cornus Kousa* BUERG. (Taf. VIII, Fig. 3), *Spirogyra setiformis* (Taf. IX, Fig. 5), *Vicia faba* L. (Taf. X, Fig. 14), *Magnolia liliflora* DESR., *Polystichum aculeatum* SCHOTT. var. *japonicum* CHRIST. (Taf. X, Fig. 5)). Wenn die oben erwähnten Veränderungen nebeneinander in derselben Zelle auftreten, dann erscheint das Bild sehr kompliziert. Übrigens ist es nicht ausgeschlossen, dass die oben geschilderten Veränderungen zum Teil auf die Wirkung des Ammoniaks beruhen, das bei der oxydativen Reaktion aus dem Amminkomplex frei gemacht wird (vergl. oben S. 44).

## V. Die Verbreitung der durch Metallkomplexsalze vitaloxydierbaren Substanzen

Im Gegensatz zu Wasserstoffsuperoxyd, fluorescierenden Farbstoffen u.a., finden gewisse Metallammine als das Reagens für die vitale Oxydation einen ungemein weiten Anwendungsbereich. Nur bei den meisten chlorophylllosen niederen Pflanzen fielen die Versuche negativ aus; bei den Bakterien (z.B. *Bacillus coli, Bacillus phosphorescens, Micrococcus luteus,* u.a.), Myxomyceten (z.B. *Hemitrichia clavata, Dictydium cancellatum, Fuligo septica* u.a.) und Pilzen (z.B. *Saccharomyces cerevisiae; Aspergillus niger, Aspergillus oryzae; Cortinellus edodes, Clitocybe sp.* u.a.),[1] bekam ich bisher keine oder sehr zweifelhafte Reaktion.

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(1) Die Pilze wie *Russula, Lactarius* u. a., die bekanntlich leicht oxydierbare Substanzen enthalten, habe ich leider nicht untersucht.

Bei den Gefässpflanzen konnte ich dagegen die vitalen Oxydations-phänomene in den Zellen fast sämmtlicher Organe feststellen. Bequemlichkeitshalber habe ich aber hauptsächlich die Blattepidermiszellen als Untersuchungsmaterial verwendet, um einige Vorstellung über die Verbreitung der Erscheinung zu gewinnen. Zu diesem Zweck habe ich insgesamt 355 Pflanzenarten und -varietäten aus verschiedensten Verwandtschaftskreisen (etwa 98 Familien und 253 Gattungen) von Phanerogamen und Pteridophyten auf vitale Oxydation untersucht. Das Ergebnis lautet:

| Reaktionsgrad | Zahl der Pflanzenarten |
|---|---|
| negativ oder zweifelhaft . . . . . . . . . | 43 |
| positiv in weniger als 50% Zellen . . . . . | 102 |
| positiv in mehr als 50% Zellen . . . . . . | 210 |
| | 355 |

$$\therefore \quad \frac{312}{355} \times 100 = 87.9\%$$

Die positive Reaktion kommt also der grossen Mehrzahl (87.9%) der untersuchten Fällen zu. Übrigens muss man hierbei den Umstand in Betracht ziehen, dass die Reaktion bei derselben Pflanze, je nach Standorts-, Belichtungs- und sonstigen Lebensverhältnissen, verschieden stark ausfallen kann. Was die chemische Natur der oxydierbaren Substanzen anbetrifft, so ist mit Wahrscheinlichkeit anzunehmen, dass in vorliegenden Fällen die Flavonderivate, deren allgemeine Verbreitung in Epidermisgeweben von K. SHIBATA[1] nachgewiesen worden ist, eine grosse Rolle spielen.

## VI.   Über die Vitalität der oxydierten Zellen

Die Metallammine wie Chloropentamminkobaltichlorid sind in merkwürdiger Weise an sich selbst ungiftig und lassen die oxydative Reaktion in lebenden Zellen zu stande kommen. Es interessiert uns nun die Frage: Wie lang fährt sich eine Zelle, die verschieden stark oxydierten Inhalt führt, mit ihrer Lebensfähigkeit fort? Um die

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(1) K. SHIBATA, M. KISHIDA u. I. NAGAI: Bot. Magaz. Tokyo, **29** (1915), 118 u. 301, **30** (1916), 149.

Vitalität der Zellen zu prüfen, bedient man sich verschiedener Methoden. Unter denselben sind die Vitalfärbung, vitale Fällung und vitale Silberausscheidung aus leicht ersichtlichen Gründen auf unseren Fall nicht anwendbar, da die vitaloxydierten Zellen schon reichlich die ebensolche Reaktionen vortäuschenden Erscheinungen aufweisen.

Mit der plasmolytischen Methode ist es leicht nachzuweisen, dass die im gewissen Grad oxydierten Zellen noch lebendig sind. Zum Beispiel sind die Zellen der Staubfadenhaare von *Rhoeo discolor*, die mit 1/50 Mol Chloropentamminkobaltichloridlösung während $3^1/_2$ Stunden bei 20°C. behandelt wurden und sich gelb veränderten, noch plasmolysierbar mit 0.5 Mol Rohrzuckerlösung und auch dann deplasmolysierbar. Bei Schleimdrüsen von *Pinguicula vulgaris*, sind die Zellen, die sich durch Oxydation hellgelb färbten, noch plasmolysierbar mit 1 Mol Rohrzuckerlösung und dann deplasmolysierbar. In noch stärker oxydierten Zellen, die schon viele Präzipitationen und tiefbraune Farbe zeigten, fielen die plasmolytischen Versuche zumeist negativ aus. Aber nach REINHARDT[1], WALTER[2], PUCHINGER[3], BENDER[4], FLURI[5], SZÜCS[6] u.a., gibt es Fälle, in denen die lebenden Zellen unter bestimmten Umständen keine Plasmolysierbarkeit zeigen, während nach SCHNEIDER[7] gewisse tote Zellen sich plasmolysieren lassen, was freilich nicht rückgängig gemacht werden kann. Da die Chloroplastenbänder von den mit Chloropentamminkobaltichlorid vital oxydierten *Spirogyra*zellen steif werden und die Plasmolysierbarkeit aufheben, wie es von WEBER[8] bei der Cu-Wirkung bemerkt wurde, so habe ich die frischen *Spirogyra*zellen zunächst teilweise zentrifugiert. Die Zentrifugierung dauerte 10 Minuten, unter 3000 Umdrehungen pro Minute. Ich habe diese Zellen mit verlagerten Protoplasten in der Lösung von 1/100 Mol Chloropentamminkobaltichlorid während 67 Minuten bei 24°C. gehalten. Die damit vital oxydierten Zellen, welche hellbraune Farbe und Präzipitationen zeigten, waren noch zu 45 Prozent mit 0.5 Mol Rohrzuckerlösung plasmolysierbar und ferner deplasmolysierbar. Aber in den Zellen, die schon so stark oxydiert wurden, dass sich braune Klümpchen im Zellsaft bildeten, konnte ich auch in obiger Weise reine Plasmolysierbarkeit feststellen.

(1)  M. O. REINHARDT : SCHWENDENER-Festschrift, Berlin, (1899), 415.
(2)  H. WALTER : Jahrb. f. wiss. Bot., **62** (1923), 147.
(3)  H. PUCHINGER : Anz. Akad. d. Wiss. Wien, math.-nat. Kl., **59** (1922), 21.
(4)  F. BENDER : Diss. Münster i. W. (1916).
(5)  M. FLURI : Flora, **99** (1909), 81.
(6)  J. SZÜCS : Jahrb. f. wiss. Bot., **52** (1913), 269.
(7)  E. SCHNEIDER : Zeitschr. f. wiss. Mikroskopie, **42** (1925), 32.
(8)  F. WEBER : Ber. d. deut. bot. Ges., **43** (1925), 217.

Bei den meisten untersuchten Zellen war eine Plasmaströmung überhaupt nicht zu beobachten. Falls sie vorhanden ist, bekommt man natürlich ein unzweideutiges Zeichen der Lebendigkeit der Zellen. In den Staubfadenhaaren von *Rhoeo discolor* die in eine Lösung von 1/50 Mol Chloropentamminkobaltichlorid während 3 Stunden getan wurden und sich hellgelb oxydiert hatten, habe ich nicht nur die Plasmaströmung, sondern auch den Umzug des Kernes sehr deutlich nachweisen. In den Blattepidermiszellen von *Nandina domestica* Thunb., welche bei der Behandlung mit 1/50 Mol Chloropentammin-kobaltichloridlösung während 1½ Stunden bei 30°C. gelbbraune Farbe und viele Granulationen zeigten, habe ich auch eine lebhafte Protoplasmaströmung 30 Minuten lang beobachtet.

Der tadelloseste Beweis der Vitalität wird schliesslich durch die Weiterkultivierung der oxydierten Zellen erbracht. Die *Spirogyra*zellen,[1] die bei Behandlung mit 1/100 Mol Chloropentamminkobalti-chloridlösung während 1½ Stunden bei 24°C. hellgelbe Farbe und geringe Präzipitation zeigten, wurden 21 Tage lang kultiviert und ergaben eine deutliche Zellteilung, wie in Tafel IX, Fig. 6 gezeigt. In diesen Zellen wurden die Oxydationsprodukte wie Farbstoffe oder Präzipitationen fast vollständig resorbiert. Einige Zellen, die den normalen Zustand nicht wieder erlangt haben, scheinen von gesunden Schwesterzellen zurückgedrängt zu werden. Weitaus grössere Zahl der sichtbar oxydierten *Spirogyra*zellen starben aber allmählich in der Kultur, was aber bei diesem empfindlichen Objekt nicht so sehr befremdend ist.

Nach Kinoshita[2] können die verschiedenen Kobaltamminkomplex-verbindungen für die Kulturen von *Aspergillus oryzae, Asp. niger* und *Penicillium glaucum*, sogar als Stickstoffquelle dienen, und die Metall-komplexkationen werden dabei als solche von den Pilzzellen aufgenom-men und im Plasma zersetzt, wodurch deren stickstoffhaltige Gruppen zum Körperbau herangezogen werden können.

Ferner habe ich einen Schleimpilz und einige höhere Pflanzen im chloropentamminkobaltichloridhaltigen Nährmedium kultiviert. Auf einen mit 1/500 Mol Chloropentamminkobaltichlorid versetzten Agar-boden, war das Plasmodium von *Dictydium cancellatum* Macbr. gut,

(1) Ich habe 35 Fäden, in welchen sich sämmtliche Zellen oxydiert zeigten, ausgewählt und sie im filtrierten Teichwasser mit nötiger Rücksicht auf Temperatur, Belichtung und Acidität kultiviert.

(2) K. Kinoshita: Acta Phytochim., **3** (1927), 31.

beweglich nach 4 Tagen bei 30°C. *Vicia faba* L. und *Hordeum sativum* JESS. var. *vulgare* HACK. gediehen in einer 1/500 Mol Chloropentamminkobaltichloridenthaltenden KNOPschen Lösung wochenlang, wenn auch das Wachstum etwas gehemmt im Vergleich mit den Kontrollkulturen erschien. Da *Vicia faba* leicht oxydierbare Substanzen enthält, wurden die Zellen verschiedener Organe dabei vital oxydiert und grün bis hell bräunlich grün verfärbt.

Aus allen oben angeführten Beobachtungen geht es klar hervor, dass die mit Chloropentamminkobaltichlorid erzielte Oxydation des Zellinhaltes eine wahre vitale Reaktion ist.

## VII. Der Einfluss des Chloropentamminkobaltichlorids auf Respiration, $CO_2$-Assimilation, Wachstum und Zygotenbildung von Spirogyra

Um einiges über die physiologischen Wirkungen vom Metallkomplexsalz, unseren vitaloxydativen Reagens, kennenzulernen, habe ich die nachfolgend beschriebenen Versuche angestellt. Als Versuchsobjekt wählte ich eben *Spirogyra*, die bekanntlich gegen verschiedene schädliche Einflüsse sehr empfindlich ist.

### (a) *Einfluss auf die Respiration*

Da Chloropentamminkobaltichlorid eine oxydaseartige Wirkung entfaltet, ist die Frage naheligend, ob es irgend einen Einfluss auf den Respirationsvorgang ausüben werde. Die Versuche wurden nach der von OSTERHOUT[1] aufgestellte Methode ausgeführt. Die erhaltenen Resultate sind in der Tabelle VIII und Fig. 7 dargestellt.

### TABELLE VIII

Relative Intensität der Respiration, die durch die OSTERHOUTsche „komparative" Methode bestimmt wurden
Material. *Spirogyra setiformis* Temperatur. 25°C.

| | Relative Intensität der Respiration | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/250 Mol Chloropentamminkobaltichlorid | Nach 3 Min. | „ 7 „ | „ 12 „ | „ 16 „ | „ 19 „ | „ 25 „ | „ 40 „ | „ 66 „ | „ 105 „ | „ 137 „ | |
| | 1.18 | 1.40 | 1.85 | 1.30 | 0.80 | 0.42 | 0.33 | 0.29 | 0.36 | 0.27 | |

(1) W. J. V. OSTERHOUT: Jour. Gen. Physiol., **1** (1918), 17.

## TABELLE VIII    (*Fortsetzung*)

| | Relative Intensität der Respiration | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/2500 Mol Chloropentammin-kobaltichlorid | Nach 4 Min. | ,, 12 | ,, 19 | ,, 24 | ,, 31 | ,, 41 | ,, 52 | ,, 68 | ,, 85 | ,, 96 | ,, 106 |
| | 0.96 | 0.92 | 0.96 | 1.22 | 1.50 | 1.67 | 1.76 | 1.52 | 1.19 | 1.08 | 1·02 |
| 1/25000 Mol Chloropentammin-kobaltichlorid | Nach 3 Min. | ,, 10 | ,, 25 | ,, 45 | ,, 60 | ,, 73 | ,, 85 | ,, 100 | ,, 111 | ,, 123 | ,, 131 |
| | 0.92 | 0.86 | 0.90 | 0.96 | 1.16 | 1.46 | 1.80 | 1.93 | 1.99 | 194 | 170 |
| 1/250 Mol CoCl$_2$ | Nach 4 Min. | ,, 9 | ,, 18 | ,, 28 | ,, 41 | ,, 59 | ,, 80 | ,, 101 | | | |
| | 0.95 | 0.91 | 0.82 | 0.82 | 0.78 | 0.68 | 0.48 | 0.46 | | | |
| 1/250 Mol CoSO$_4$ | Nach 6 Min. | ,, 18 | ,, 36 | ,, 57 | ,, 80 | ,, 112 | | | | | |
| | 0.80 | 0.54 | 0.30 | 0.20 | 0.12 | 0.14 | | | | | |
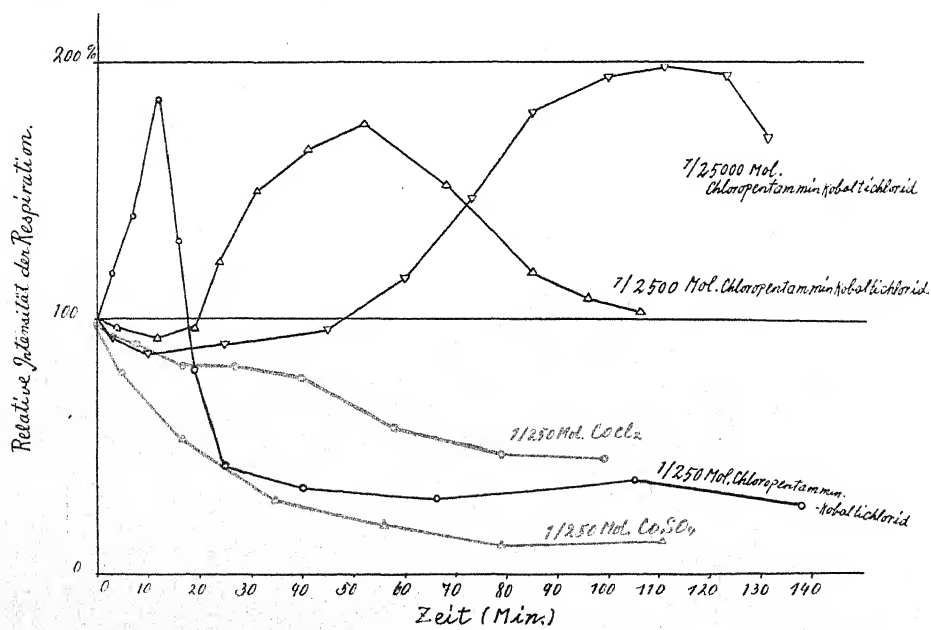


Fig. 7

Hieraus ist ersichtlich, dass die Respirationsintensität durch Chloropentamminkobaltichlorid zunächst gesteigert und dann allmählich erniedrigt wird. Diese Resultate gleichen denjenigen, die BROOKS,[1] GUSTAFSON,[2] THOMAS[3] u.a. bei *Bacillus subtilis, Aspergillus niger, Triticum vulgare* u.a. mit Äther und anderen Substanzen gewonnen haben. Der Maximalwert wird verschieden schnell erreicht je nach der Salzkonzentration. In höherer Konzentration (1/250 Mol), beginnt das Ansteigen der Kurve schon im Augenblick der Salzwirkung. Je geringer die Konzentration des Komplexsalzes ist, um so später erscheint diese Steigerung, und ferner ist es auffallend, dass bei niedrigen Salzkonzentrationen (1/2500 u. 1/25000 Mol) eine anfängliche Verminderung der Respirationsrate beobachtet wird. Dagegen mit 1/250 Mol $CoCl_2$ und $CoSO_4$ kann man keine Steigerung, sondern eine stete Verminderung der Atmungsintensität wahrnehmen. Deshalb scheint es sicher zu sein, dass die oben gezeigte Beschleunigung der Respiration durch eine spezifische Wirkung vom Chloropentamminkobaltichlorid (Komplexkation) hervorgerufen wird. Was den zeitlichen Verlauf anbelangt, so erscheint die Steigerung der Respirationsintensität lange bevor die intrazellularen Oxydationsphänomene mikroskopisch nachweisbar werden; im Momente, wo die Farbenveränderungen und Präzipitationen in den Zellen auftreten, geht schon die Atmung stark zurück.

### (b) *Einfluss auf die* $CO_2$-*Assimilation*

Zur Feststellung der Intensität der $CO_2$-Assimilation von *Spirogyra*, habe ich die Veränderung des pH-Wertes vom Kulturwasser kolorimetrisch gemessen. Das im Wasser gelöste Kohlendioxyd wird von grünen Zellen mit der Zeit verzehrt. 0.5 g. von *Spirogyra*-Fäden konnten dadurch unter günstiger Belichtung den pH-Wert vom pufferarmen Leitungswasser um pH 0.2 pro 10 Minuten nach der alkalischen Seite verschieben, und nach 160 Minuten stieg der pH-Wert dieses Wassers sogar auf 9.9.

Die *Spirogyra*-Fäden wurden zunächst in einer 1/100 Mol Chloropentamminkobaltichloridlösung während 10, 60 bezw. 120 Minuten eingetaucht und dann mit Leitungswasser während 20 Minuten gewaschen. 0.5 g. von diesen mit Filtrierpapier oberflächlich getrockneten Fäden werden in 200 ccm Leitungswasser in einem Pyrexglasbecher getan und unter Sonnenlicht bei konstanter Temperatur (Wasserstromkühlung) gehalten. Aus der in bestimmten Zeitinter-

(1) M. M. BROOKS: Jour. Gen. Physiol., **1** (1918), 193.
(2) F. G. GUSTAFSON: Jour. Gen. Physiol., **1** (1918), 186.
(3) H. S. THOMAS: Jour. Gen. Physiol., **1** (1918), 203.

vallen gemessenen pH-Wert-Veränderung in Versuchs- und Kontrol-
kulturen berechnete ich die relativen Werte der Assimilationsinten-
sität, welche in der Tab. IX und Fig. 8 angegeben sind.

<div align="center">

TABELLE IX

Relative Intensität der $CO_2$–Assimilation
Material.........*Spirogyra setiformis*
Temperatur.........25°C.

</div>

| Dauer der Behandlung mit 1/100 Mol Chloropentammin-kobaltichlorid-lösung | Relative Intensität der Assimilation | | | | | | |
|---|---|---|---|---|---|---|---|
| | Nach 20 Min. | ,, 40 ,, | ,, 60 ,, | ,, 80 ,, | ,, 100 ,, | ,, 120 ,, | ,, 160 ,, |
| 10 Min. | 0.80 | 0.78 | 0.89 | 0.77 | 0.84 | 0.85 | 0.88 |
| 60 ,, | 0.20 | 0.22 | 0.33 | 0.30 | 0.43 | 0.54 | 0.59 |
| 120 ,, | 0.20 | 0.22 | 0.17 | 0.09 | 0.09 | 0.15 | 0.15 |
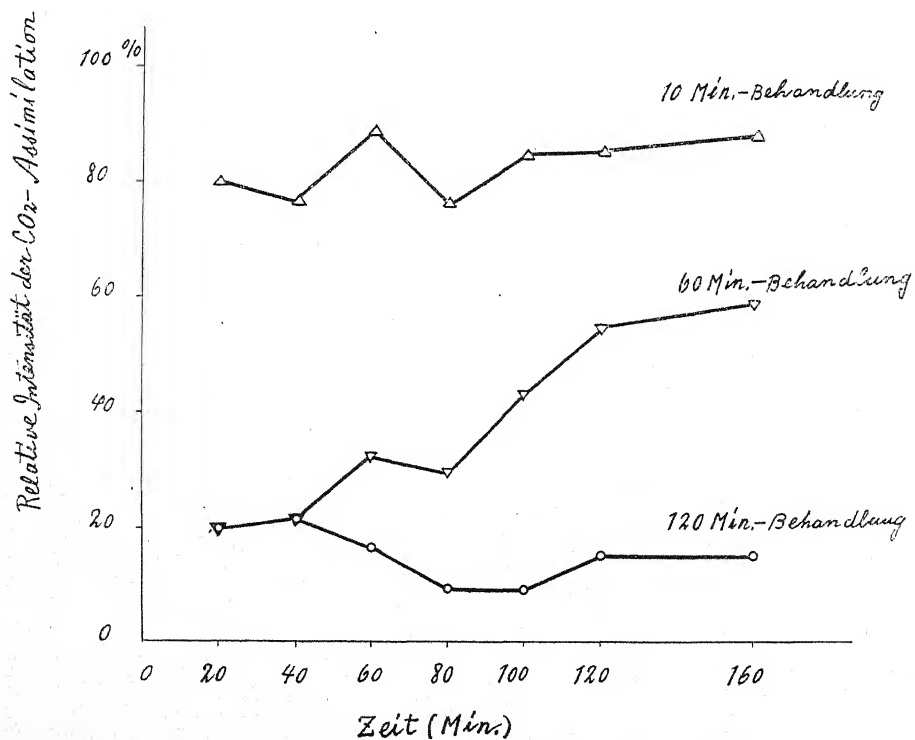


Fig. 8

Hieraus ersieht man, dass Kobaltamminsalz überall eine Hemmung der Assimilation verursacht. Aber bei den Exemplaren mit mehr knapper Salzbehandlung (10 und 60 Minuten) ist eine Tendenz zur Wiederherstellung der normalen Intensität gut bemerklich.

(c) *Einfluss auf das Wachstum*

Die Gewichtszunahme der Fadenmasse und die Vermehrung der Zellenzahl in einem Faden wurden als Kriterien des stattgefundenen Wachstums benutzt. Bei einem Versuche werden die *Spirogyra*-Fäden in einer 1/100 Mol Chloropentamminkobaltichloridlösung verschieden lange Zeit (5, 10, 30, 60, 90, 120, 150 und 180 Minuten) und bei einem anderen Versuch während 150 Minuten in verschieden konzentrierten Lösungen (1/5000, 1/2500, 1/500, 1/250, 2/250, 3/250, 4/250 und
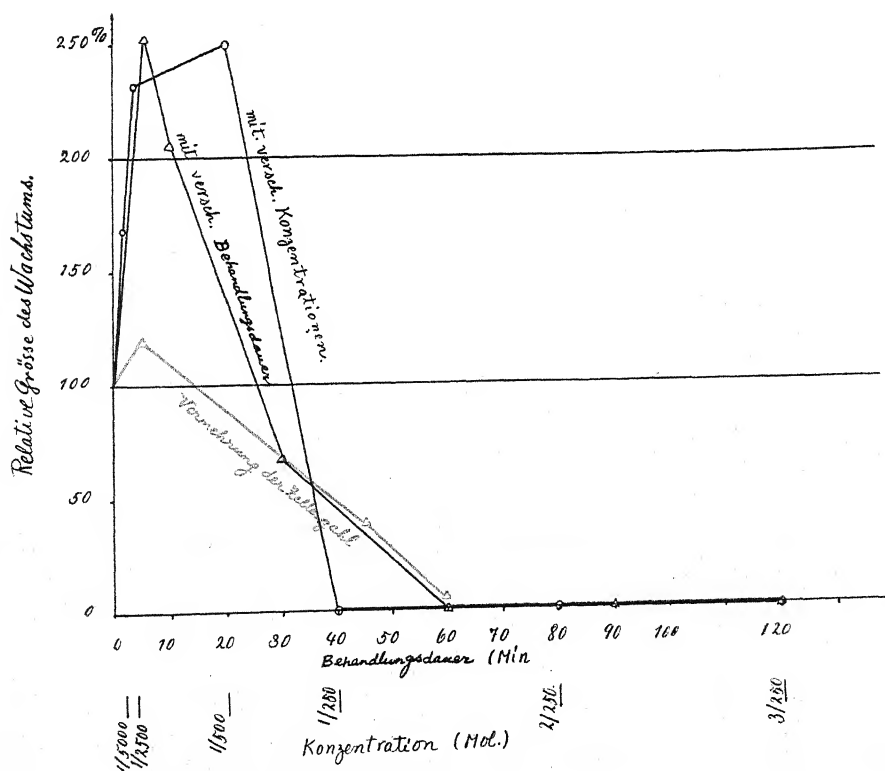
Fig. 9

## TABELLE X

Das Wachstum von *Spirogyra setiformis* nach Behandlung mit
Chloropentamminkobaltichlorid

| Dauer der Behandlung mit 1/100 Mol Lösung | Ursprüngl. Gewicht g | Gewicht nach 13 Tagen g | Differenz g | Relative Wachstums-grösse |
|---|---|---|---|---|
| 0 Min. | 0.5 | 0.73 | Im | |
| | 0.5 | 0.68 | Durchschnitt | |
| | 0.5 | 0.66 | 0.19 | |
| 5 Min. | 0.5 | 0.98 | 0.48 | 2.53 |
| 10 ,, | 0.5 | 0.89 | 0.39 | 2.05 |
| 30 ,, | 0.5 | 0.63 | 0.13 | 0.68 |
| 60 ,, | 0.5 | 0.45 | (—) 0.05 | 0 |
| 90 ,, | 0.5 | 0.49 | (—) 0.01 | 0 |
| 120 ,, | 0.5 | 0.44 | (—) 0.06 | 0 |
| 150 ,, | 0.5 | 0.43 | (—) 0.07 | 0 |
| 180 ,, | 0.5 | 0.45 | (—) 0.05 | 0 |

## TABELLE XI

Das Wachstum von *Spirogyra setiformis* nach Behandlung mit
Chloropentamminkobaltichlorid

| Konzentration von Lösung (Behandlungsdauer: 150 Minuten) | Ursprüngliches Gewicht g | Gewicht nach 13 Tagen g | Differenz g | Relative Wachstums-grösse |
|---|---|---|---|---|
| 0 Mol | 0.5 | 0.66 | Im | |
| | 0.5 | 0.73 | Durchschnitt | |
| | 0.5 | 0.77 | 0.22 | |
| 1/5000 ,, | 0.5 | 0.87 | 0.37 | 1.68 |
| 1/2500 ,, | 0.5 | 1.01 | 0.51 | 2.31 |
| 1/500 ,, | 0.5 | 1.05 | 0.55 | 2.50 |
| 1/250 ,, | 0.5 | 0.35 | (—) 0.15 | 0 |
| 2/250 ,, | 0.5 | 0.42 | (—) 0.08 | 0 |
| 3/250 ,, | 0.5 | 0.43 | (—) 0.07 | 0 |
| 4/250 ,, | 0.5 | 0.48 | (—) 0.02 | 0 |
| 5/250 ,, | 0.5 | 0.33 | (—) 0.17 | 0 |

5/250 Mol) eingetaucht. Von jeder Fadenmasse werden 0.5 g. frisch abgewogen, und unter gleichen Bedingungen wie die Kontrolle 13 Tage lang kultiviert. Die beobachtete Gewichtsveränderung ist in den Tab. X und XI angegeben. Um die Veränderung der Zellenzahl festzustellen, habe ich jeden einzelnen *Spirogyra*-Faden von bekannter Zellenzahl in einem Becher kultiviert und nach 20 Tagen beobachtet. Die erhaltenen Resultate sind in der Tabelle XII angegeben. (Siehe auch Fig. 9).

Aus diesen Ergebnissen sieht man, dass das Wachstum bei schwächerer Einwirkung des Komplexsalzes beschleunigt und bei stärkerer gehemmt wird. Weil gewisse oxydierte Zellen mit der Zeit

## TABELLE XII

Vermehrung der Zellenzahl von *Spirogyra setiformis*

| Dauer der Behandlung mit 1/100 Mol Lösung von Chloropentammin-kobaltichlorid | Ursprüngliche Zellenzahl (A) | Zellenzahl nach 13 Tagen (B) | Differenz | Schnelligkeit der Zellvermehrung $\left(\dfrac{A}{B}\right)$ | Relative Grösse |
|---|---|---|---|---|---|
| 0 Min. | 26 | 38 | 12 | 0.46 | |
| | 12 | 24 | 12 | 1.00 | |
| | 31 | 38 | 7 | 0.22 | |
| | 17 | 20 | 3 | 0.18 | |
| | | | | m. 0.465 | |
| 5 ,, | 21 | 35 | 14 | 0.97 | |
| | 15 | 28 | 13 | 0.88 | |
| | 17 | 19 | 2 | 0.12 | |
| | 9 | 14 | 5 | 0.56 | |
| | | | | m. 0.557 | 1.18 |
| 45 ,, | 13 | 13 | 0 | 0 | |
| | 7 | 8 | 1 | 0.14 | |
| | 23 | 21 | (—) 2 | 0 | |
| | 13 | 16 | 3 | 0.23 | |
| | | | | m. 0.185 | 0.36 |
| 60 ,, | 15 | 14 | (—) 1 | 0 | |
| | 11 | 12 | 1 | 0.09 | |
| | 17 | 16 | (—) 1 | 0 | |
| | 30 | 31 | 1 | 0.03 | |
| | | | | m. 0.06 | 0.01 |
| 90 ,, | 15 | 5 | (—) 10 | 0 | |
| | 30 | 28 | (—) 2 | 0 | |
| | 21 | 18 | (—) 3 | 0 | |
| | | | | m. 0 | 0 |

das Leben verlieren und auch von den gesund gebliebenen verdrängt und resorbiert werden, ist es leicht verständlich, dass bei stärker beeinflussten Fäden Gewichts- und Zellenzahlabnahme eintritt. Immerhin handelt es sich hier um ein Durchschnittverhältnis und einzelne sichtbar oxydierte Zellen, wie wir schon oben bemerkten, stellen den normalen Zustand wieder her und sogar vermehren sich durch Teilung..

### (d) Einfluss auf die Zygotenbildung

Durch die Versuche von KLEBS,[1] ULEHLA,[2] BENECKE[3] u.a. war sichergestellt, dass die Konjugation bei Spirogyra durch verschiedene äussere Eingriffe, z.B. Erhöhung des pH-Wertes, Stickstoffmangel, Entziehung von Nahrung, starke Belichtung, Temperaturerhöhung, Störung von Durchlüftung u.a., veranlasst wird. Ich habe Spirogyra in Leitungswasser in 300 ccm fassenden Bechern kultiviert. Bei ziemlich starker Belichtung stieg die Temperatur des Wassers von 20°

### TABELLE XIII

Einfluss des Chloropentamminkobaltichlorids auf die Konjugation
von *Spirogyra setiformis*

| Stadium | Dauer der Behandlung mit 1/100 Mol Chloropentamminkobaltichloridlösung | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 Min. | 5 ,, | 10 ,, | 30 ,, | 60 ,, | 90 ,, | 120 ,, | 150 ,, | 180 ,, |
| | Tag des Zustandekommens von jedem Stadium | | | | | | | | |
| Ruhende Zygoten | 7 | 7 | 11 | 11 | — | — | — | — | — |
| Zygotenbildung | 5 | 5 | 5 | 9 | — | — | — | — | — |
| Kanalbildung | 3 | 3 | 3 | 3 | — | — | — | — | — |
| Kräuselung der Chlorophyllbänder | 2 | 2 | 2 | 2 | — | — | — | — | — |

(1) G. KLEBS: Die Bedingungen der Fortpflanzung bei einigen Algen und Pilzen. Jena, 1896, 229.
(2) V. ULEHLA: Ber. d. deut. bot. Ges., **41** (1923), 20.
(3) W. BENECKE: Flora, **118** (1925), 27.

auf 29°C. und der pH-Wert von 7.1 auf 8.5. Unter diesen Bedingungen kräuselten sich die Chlorophyllbänder von über 80% Zellen nach 2 Tagen, die Kanalbildung zwischen Fäden und die Zygotenbildung traten nach 3 resp. 5 Tagen ein, und nach 7 Tagen wurden alle Zygoten im Ruhe-Stadium gefunden. Bei kurzdauernder Vorbehandlung mit 1/100 Mol Chloropentamminkobaltichloridlösung wurden diese Vorgänge etwas verzögert und bei der längerer vollständig gehemmt, wie es in der Tabelle XIII gezeigt wird.

## VIII. Zusammenfassung

1. Durch wässrige Lösungen von verschiedenen Kobaltamminkomplexverbindungen kann man die Oxydationsphänomene in den lebenden Pflanzenzellen hervorrufen, wie es zuerst von K. SHIBATA gefunden wurde.

2. Diese vitale Oxydation ist mikroskopisch leicht erkennbar durch die zumeist in Safträumen auftretende Farbenveränderung, Aggregation und Präzipitation.

3. Die Farbenveränderung tritt in meisten Fällen in folgender Reihenfolge auf : Farblos-Gelb-Braun (bis Schwarz). Aber in einigen Fällen werden anstatt Gelb Rot, Blau und auch verschiedene Zwischenfarben beobachtet. Diese farbigen Produkte entstehen aus farblosen Muttersubstanzen durch Oxydation. Die Versuche *in vitro* mit den phenolaseartig wirkenden Komplexsalzen zeigen, dass die in Frage kommenden oxydierbaren Zellinhaltstoffe nichts anders als Phenolderivate wie Flavonkörper, Gerbstoffe, Catechine u.s.w. sind.

4. Gewisse geformte Einschlüsse des Cytoplasmas (ätherische Oel- und Harztröpfchen, Fucosanblasen u.a.) und zuweilen auch Zellkerne erleiden die Oxydation.

5. Auf den zeitlichen Verlauf der vitalen Oxydation üben nicht nur die Konzentration und Einwirkungsdauer der Reagentien, sondern auch verschiedene äussere und innere Bedingungen einen grossen Einfluss aus. Was besonders die letzteren anbelangt, so sind die Acidität und Pufferwirkung des Zellsaftes ausschlaggebend.

6. Plasmolyse, Plasmaströmung und Kulturversuche liefern einen sicheren Beweis, dass die Zellen, die mit Kobaltkomplexsalzen sichtbar oxydiert sind, öfters noch lange lebendig bleiben.

7. In den chlorophylllosen niederen Pflanzen kann man die vitale Oxydation gewöhnlich nicht bewirken. Dagegen grüne Gewächse, insbesondere allermeiste Gefässpflanzen reagieren in den Zellen verschiedener Organe positiv. Die Versuche mit Epidermiszellen von verschiedensten Pflanzen ergaben, dass dort vital oxydierbare Substanzen ganz allgemein vorkommen.

8. Chloropentamminkobaltichlorid wirkt in sehr kleinen Dosen beschleunigend und in grösseren hemmend auf die Respirationsintensität und das Wachstum von *Spirogyra*. Die $CO_2$-Assimilation und die Zygotenbildung scheinen immer von Chloropentamminkobaltichlorid verzögert werden.

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# Tafelerklärung

## Tafel VIII

Fig. 2-4. Vitale Oxydation mit der 1/100 Mol Chloropentamminkobaltichlorilösung. Unveränderte Zellen zeigen sich durchsichtig.

Fig. 1. Stammepidermiszellen von *Aeginetia indica* L. Im normalen Zustand (unbehandelt).

Fig. 2. Dergleichen. Behandelt 60 Min. bei 27°C. Oxydationsfärbung und Präzipitation.

Fig. 3. Blumenblattzellen von *Cornus Kousa* BUERG. Behandelt 180 Min. bei 24°C. Wie oben.

Fig. 4. Dieselben von *Trachelospermum asiaticum* NAKAI. Behandelt 180 Min. bei 25°C. Einzelne oxydierte Zellen im plasmolyseartigen Zustand.

## Tafel IX

Fig. 1-5. Vitale Oxydation mit der 1/100 Mol Chloropentamminkobaltichloridlösung.

Fig. 1. Blattepidermiszellen von *Callicarpa japonica* THUNB. Behandelt 180 Min. bei 23°C. Aggregation mit Oxydationsfärbung.

Fig. 2. Stammepidermiszellen von *Aeginetia indica* L. Behandelt 70 Min. bei 26°C. Ebenso.

Fig. 3. Blattepidermiszellen von *Foeniculum vulgare* GAERTN. Behandelt 6 Stunden bei 15°C. Die Zellkerne zeigen auch Oxydationsfärbung.

Fig. 4. Schleimdrüsenzellen von *Brasenia Schreberi* GMEL. Behandelt 15 Min. bei 24°C. Kontraktion des Protoplasten in einem Haar.

Fig. 5. Zwei Fäden von *Spirogyra setiformis*, welche eben Kopulationskanäle gebildet haben. Behandelt 115 Min. bei 23°C. Man bemerke die ungleiche Oxydationsgeschwindigkeit von beiden konjugierenden Fäden.

Fig. 6. Fäden von *Spirogyra setiformis*, die mit 1/100 Mol Chloropentamminkobaltichloridlösung während 90 Min. bei 24°C. vital oxydiert und dann im Leitungswasser 21 Tage lang kultiviert wurden. Die Fäden links und rechts sind normal lebendig mit geteilten und von Oxydationsprodukten befreiten Zellen. Einzelne abgestorbene Zellen mit dunklem Inhalt werden von Schwesterzellen zerdrückt. Mitten ein Faden mit den zwar in oxydiertem Zustand geteilten, aber nachher abgestorbenen Zellen.

Tafel x

Fig. 1–14.  Vitale  Oxydation  mit  der  1/100  Mol  Chloropentamminkobalti-chloridlösung.  Verschiedene Oxydationsfärbungen, Aggregation und Präzipitation. K bedeutet die unveränderten, im normalen Zustand befindlichen Zellen.

Fig.  1.  Blattepidermiszellen von *Primula modesta* BISS. et MOORE.

Fig.  2.  Dieselben von *Paphiopedilum Spicerianum* PFITZ.

Fig.  3.  Dieselben von *Erythroxylum Coca* LAM.

Fig.  4.  Dieselben von *Arundinaria Simoni* RIV.

Fig.  5.  Dieselben von *Polystichum aculeatum* SCHOTT. var. *japonicum* CHRIST.

Fig.  6.  Tentakelzellen von *Drosera longifolia* L. Unveränderte Zelle (K) mit Anthocyan.

Fig.  7.  Blattepidermiszellen von *Phytolacca esculenta* HOUTT.  Unveränderte Zelle (K) mit Anthocyan.

Fig.  8.  Dieselben von *Vicia sativa* L. var. *normalis* MAKINO.

Fig.  9.  Dieselben von *Liriope graminifolia* BAK.

Fig. 10.  Blattnervzellen von *Rhus vernicifera* DC.

Fig. 11.  Blattepidermiszellen von *Lactuca debilis* BENTH. et HOOK. f.

Fig. 12.  Dieselben von *Sophora japonica* L.

Fig. 13.  Trichomdrüsen von *Pinguicula vulgaris* L.

Fig. 14.  Dieselben von *Vicia Faba* L.
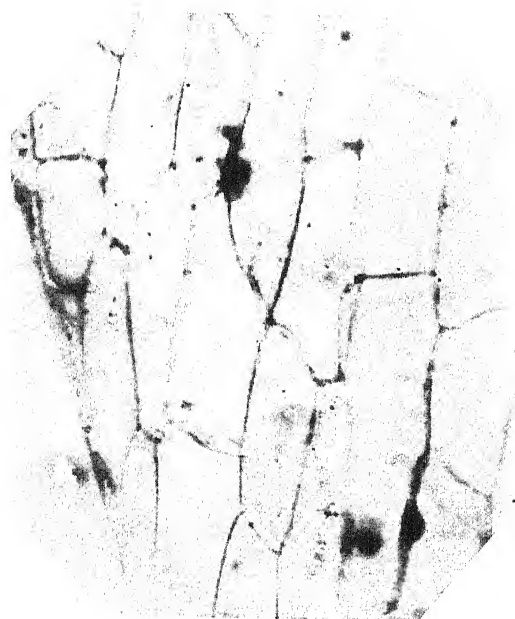
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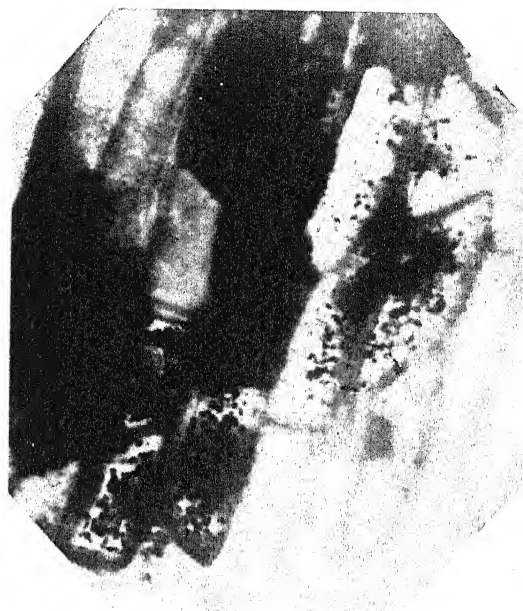


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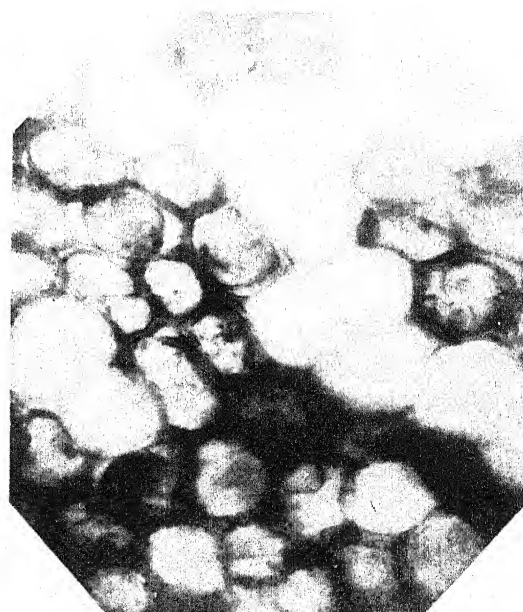


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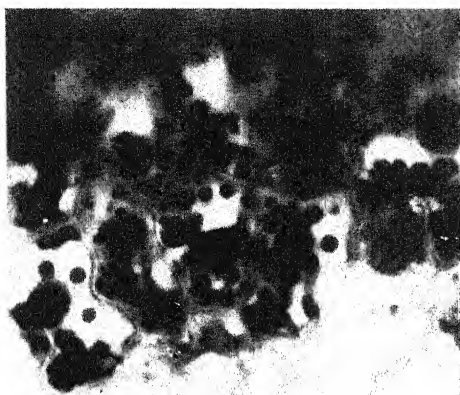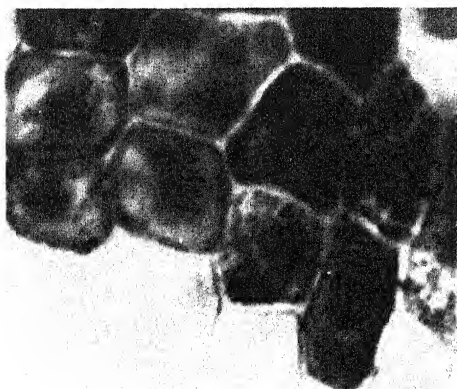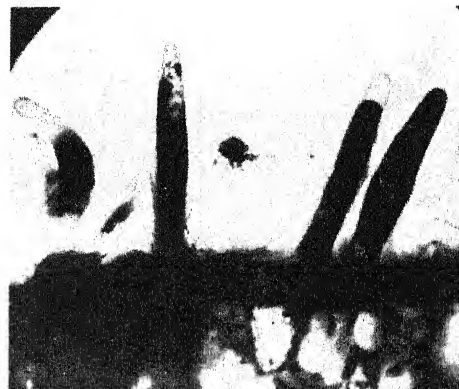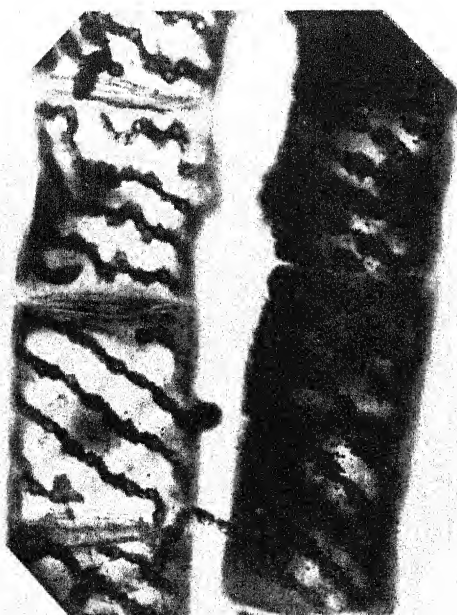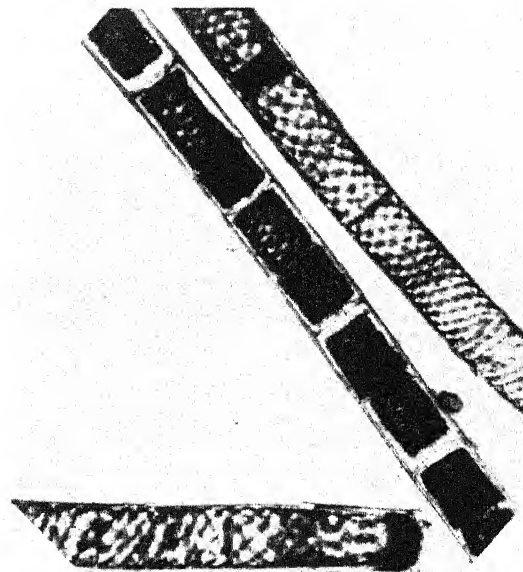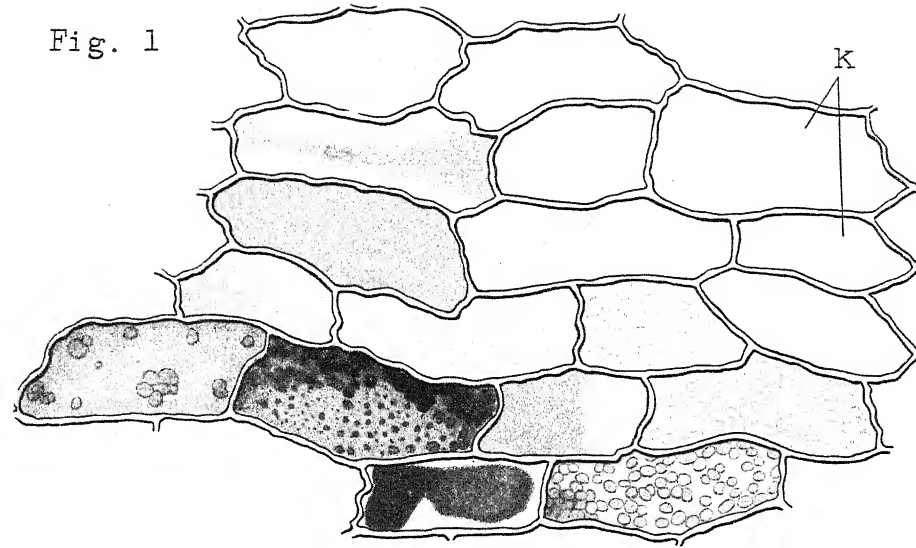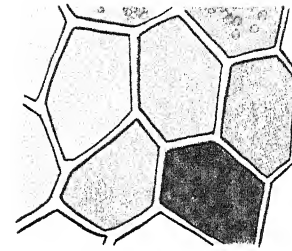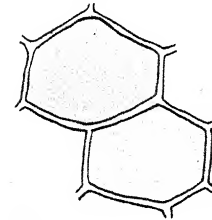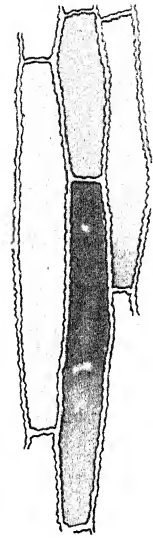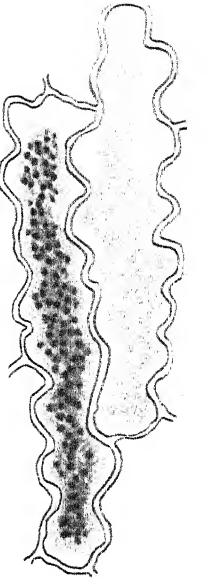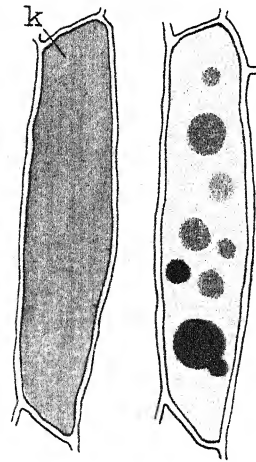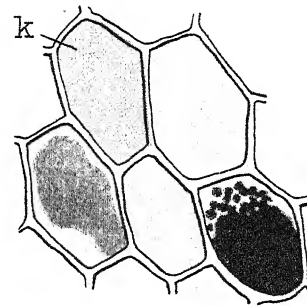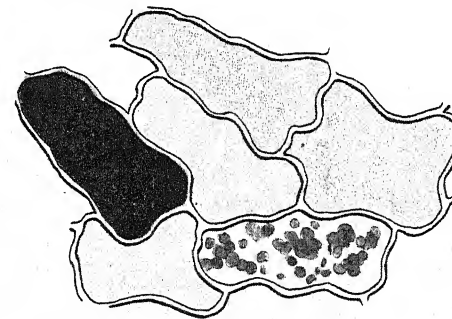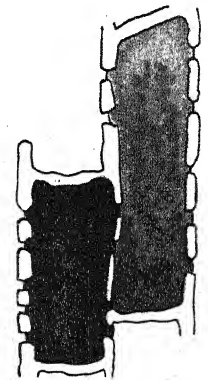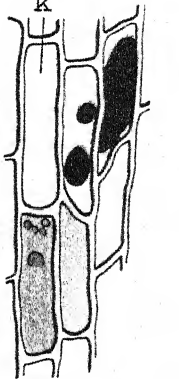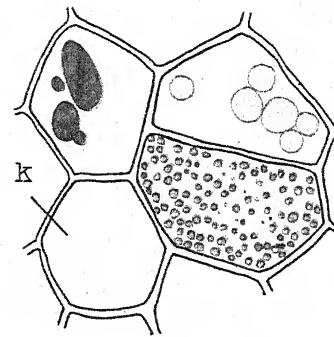
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Tafel X

Fig. 1    k

Fig. 3

Fig. 4    Fig. 5

Fig. 2

Fig. 6    k

Fig. 7    k

Fig. 8

Fig. 9

Fig. 10    k

Fig. 11    Fig.12    k    Fig.13    k    Fig. 14    k
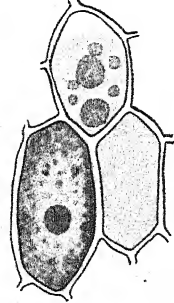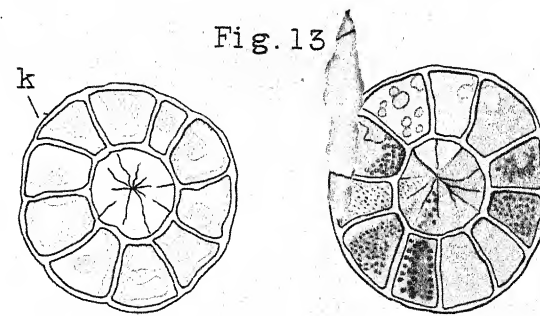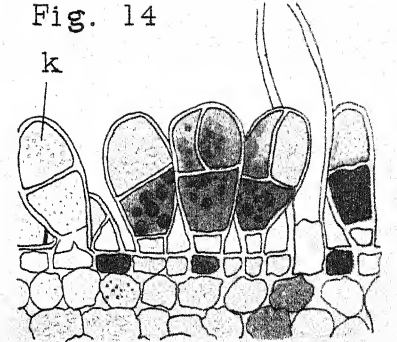
# The Effect of Renewal of Nutrient Solutions upon the Growth of Culture Plants and its Relation to Aëration

By Tsung-Lê LOO[1] (羅宗洛)

(from Chiekiang, China)

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With 5 Text-figures

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In earlier papers (1927-a and 1927-b), the writer has made clear the fact that the hydrogen ion concentration of the culture medium undergoes rapid change within a few hours when in contact with the roots of culture plants and that this change may seriously affect the plant growth. This ill effect can be avoided or at least lessened to some extent by adding phosphates or calcium chloride to the solution or by using a combination of two ammonium salts, such as $(NH_4)_2SO_4$ and $NH_4HCO_3$, as the source of nitrogen, instead of single one. Another method of preventing the harmful effect of the acidity thus increased, namely, the renewal of the nutrient solution, was adopted, and a number of experiments were carried out in the years 1924 and 1926. The results of these experiments will be described in following pages.

The present paper deals with (1) the daily change of pH-value of the nutrient solutions which were renewed once a day; (2) comparative studies of the effect of the renewed and non-renewed solutions upon the growth of plants; (3) the effect of aëration of the nutrient solutions upon plant growth.

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(1) In some papers, in which the writer's previous works were cited, his name was written as "Loo-Tsung-Lê" or "Tsung-Lê-Loo". He dislikes such arbitrary change of his name and requests that his name should be put as it is, otherwise simply "T. L. Loo" or "Loo".

The methods of experimentation were exactly the same as in the previous works and therefore need not to be again described here. However it may be convenient for easy understanding to write down here the formula of the stock solutions.

Stock solution, part A :

| | | | |
|---|---|---|---|
| Magnesium sulphate . . . . . | $MgSO_4.7H_2O$ | 5 | gm. |
| Potassium biphosphate . . . . | $KH_2PO_4$ | ,, | ,, |
| Calcium chloride (crystal). . . | $CaCl_2.6H_2O$ | 0.97 | ,, |
| Distilled water. . . . . . . . | | 1000 | cc. |

Stock solution, part B :

| | | | | | |
|---|---|---|---|---|---|
| (a) | Ammonium nitrate. . . | $NH_4NO_3$ | 19.6 | gm. |
| (b) | ,,      chloride . . | $NH_4Cl$ | 13.2 | ,, |
| (c) | ,,      sulphate . . | $(NH_4)_2SO_4$ | 16.2 | ,, |
| (d) | ,,      biphosphate. | $NH_4H_2PO_4$ | 28.0 | ,, |
| (e) | ,,      phosphate. . | $(NH_4)_2HPO_4$ | 16.2 | ,, |
| (f) | ,,      bicarbonate . | $NH_4HCO_3$ | 14.1 | ,, |
| (g) | Sodium nitrate . . . . . | $NaNO_3$ | 20.8 | ,, |

Each of the above salts was dissolved in one litre of distilled water.

The hydrogen ion concentration of the solution was determined by the colorimetric method of CLARK and LUBS (CLARK, 1920), using the buffer mixture recommended by them.

## Change of Reaction of Nutrient Solutions which were renewed intermittently.

In the previous works just referred to, the writer has traced out the daily change of pH-value of the nutrient solutions with ammonium salts as the sources of nitrogen. The purpose of this series of experiments is to see whether the direction of change in pH-values is affected by the renewal of solutions. The material used in these experiments were the seedlings of paddy rice, buckwheat, wheat and broad beans. As culture vessels Jena glass tubes, 17 cm. long, 2.3 cm. in diameter, of the capacity of 50 cc., were used. These experiments were carried out in triplicate. The composition of the nutrient solutions was as follows :

Stock solution A . . . . . . . . . . . 50 cc.

Stock solution B . . . . . . . . . . . 50 cc.

Distilled water . . . . . . . . . . . . 2900 cc.

Sum . . . . . . . . . . . . . . 3000 cc.

These experiments all lasted 8 days. The nutrient solutions were renewed every 24 hours.

### 1. *Oryza sativa*, "Akagé"

Two experiments were carried out with different kinds of source of iron, ferric chloride in one experiment and ferrous sulphate in the other. But the results were similar. The results of one of these experiments is summarized in Table I and the reaction change is illustrated in Fig. 1 (p. 76).

### TABLE I

*Oryza sativa*: 3 plants were grown in a tube, each containing 30 cc. of nutrient solution. Culture duration: Aug. 5–12, 1924
Temp. 28°–30°C.

| N-source in the solution | pH | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial | Daily changes | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| $NaNO_3$ | 5.2 | 5.8 | 5.7 | 5.6 | 5.5 | 5.8 | 6.0 | 6.2 |
| $NH_4NO_3$ | 5.1 | 5.0 | 4.7 | 4.2 | 4.1 | 4.1 | 4.0 | 4.0 |
| $NH_4Cl$ | 5.1 | 5.1 | 4.1 | 3.9 | 4.0 | 3.9 | 3.8 | 3.7 |
| $(NH_4)_2SO_2$ | 5.1 | 4.7 | 4.1 | 3.9 | 4.0 | 4.1 | 3.9 | 3.8 |
| $(NH_4)_2HPO_4$ | 6.9 | 6.7 | 6.7 | 6.6 | 6.6 | 6.7 | 6.6 | 6.7 |
| $NH_4HCO_3$ | 7.6 | 7.8 | 7.9 | 8.0 | 8.0 | 8.0 | 8.1 | 8.2 |

### 2. *Fagopyrum esculentum*

Three experiments were worked out. The first experiment, whose results are summarized in Table II and illustrated in Fig. 2 was con-

ducted by the window of the laboratory under direct sunlight. Two plants were grown in each tube containing 40 cc. of nutrient solution with ferrous sulphate as the source of iron. The second one was different from the first only respecting the fact that the concentration of the solution was a little more diluted. The third experiment was only a repetition of the first, except that in this case ferric sulphate was used instead of ferrous sulphate. Notwithstanding the divergence of concentration and sources of iron, the results of the three experiments were similar in every respect.

TABLE II

*Fagopyrum esculentum*: 2 plants were grown in a tube, each containing
40 cc. of nutrient solution. Culture duration: Aug. 18—25, 1924
Temp. 20°—29°C.

| N-source in the solution | pH | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial | Daily changes | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| $NaNO_3$ | 5.2 | 5.4 | 5.4 | 5.3 | 5.3 | 5.4 | 5.4 | 5.5 |
| $NH_4NO_3$ | 5.1 | 4.9 | 4.8 | 4.5 | 4.4 | 4.4 | 4.4 | 4.3 |
| $NH_4Cl$ | 5.1 | 4.8 | 4.3 | 3.9 | 3.8 | 3.7 | 3.7 | 3.7 |
| $(NH_4)_2SO_4$ | 5.1 | 4.9 | 4.3 | 3.9 | 3.8 | 3.7 | 3.7 | 3.7 |
| $(NH_4)_2HPO_4$ | 6.8 | 6.7 | 6.6 | 6.6 | 6.6 | 6.6 | 6.6 | 6.6 |
| $NH_4HCO_3$ | 7.6 | 7.9 | 7.8 | 7.8 | 7.9 | 8.1 | 8.1 | 8.2 |

## 3. *Triticum vulgare*, "Martins Amber"

Two experiments were worked out, both by the window of the corridor under the sunlight. Two seedlings were grown in each tube in the first experiment and three in the second. In both experiments, a trace of iron was added to the nutrient solutions in the form of ferrous sulphate. The experimental data of the first experiment are shown in Table III and Fig. 3.

## TABLE III

*Triticum vulgare*: 2 plants in each culture containing 40 cc. of nutrient
solution. Culture duration: Aug. 25—Sept. 1, 1924
Temp. 18°—25°C.

| N-source in the solution | pH | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Initial | Daily changes | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| $NaNO_3$ | 5.2 | 5.2 | 5.2 | 5.3 | 5.5 | 5.6 | 5.4 | 5.6 | |
| $NH_4NO_3$ | 5.1 | 4.1 | 4.1 | 4.0 | 4.0 | 4.1 | 4.2 | 4.1 | |
| $NH_4Cl$ | 5.1 | 4.1 | 3.8 | 3.8 | 3.7 | 3.7 | 3.9 | 3.7 | |
| $(NH_4)_2SO_4$ | 5.1 | 4.1 | 3.9 | 3.9 | 3.7 | 3.7 | 3.9 | 3.7 | |
| $(NH_4)_2HPO_4$ | 6.9 | 6.6 | 6.5 | 6.4 | 6.4 | 6.5 | 6.6 | 6.4 | |
| $NH_4HCO_3$ | 7.6 | 7.4 | 7.5 | 7.5 | 7.3 | 7.3 | 7.4 | 7.4 | |

## 4. *Vicia Faba*

Two experiments were carried out with *Vicia Faba*. In the first
experiment, only one plant was grown in each culture. Though the
seedlings grew quite well, and the reaction change was in complete
harmony with the foregoing experiments, the scarcity of seedling in
each culture made it insufficient to draw any satisfactory conclusion.
Accordingly, in the second experiment, two plants were grown in the
same tube, containing the same quantity of nutrient solution, the con-
centration of which was as follows:

Stock solution A . . . . . . . . . .  50 cc.
Stock solution B . . . . . . . . . .  50 cc.
Distilled water . . . . . . . . . . .  3900 cc.
Sum . . . . . . . . . . . .  4000 cc.

As iron source ferrous sulphate was used. Both experiments were
carried out in the greenhouse. The plants in both experiments showed
some common growth features and the same direction in reaction
change. The results of the second experiment will be shown in Table
IV and Fig. 4.
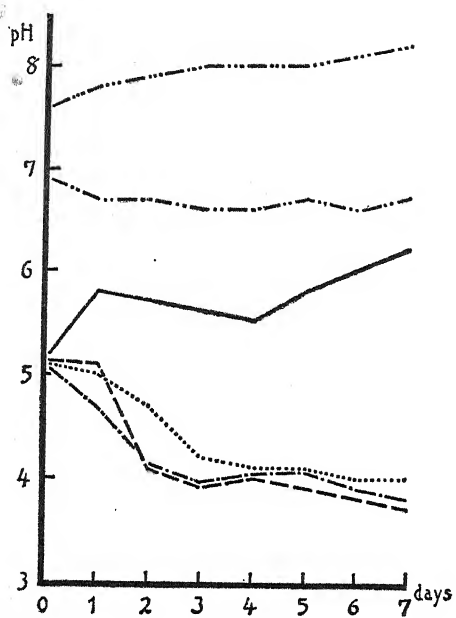
Fig. 1
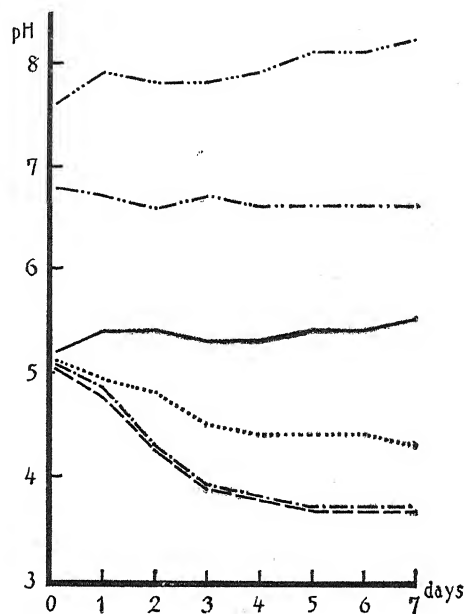


Fig. 2
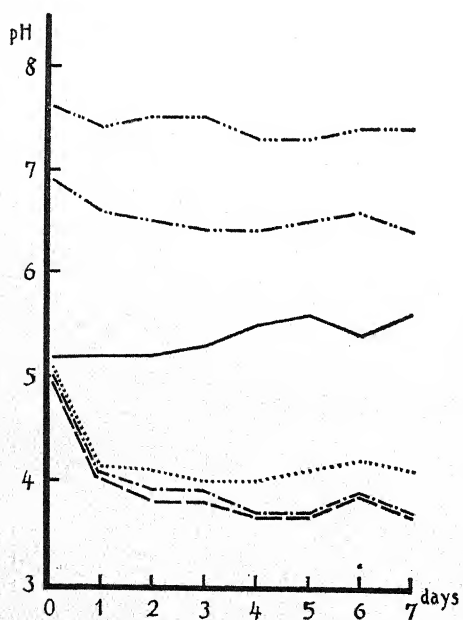


Fig. 3
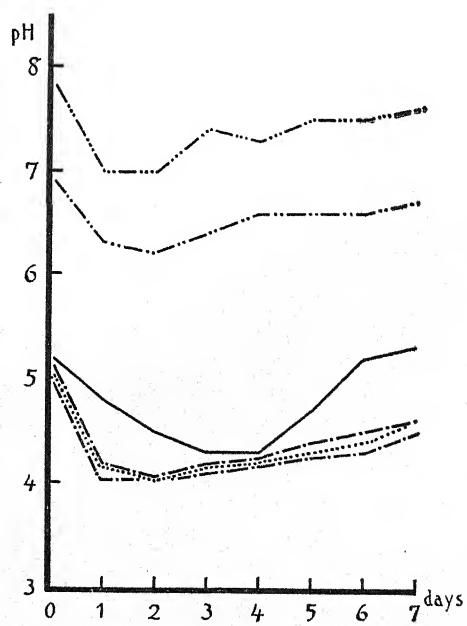


Fig. 4

Fig. 1. *Oryza sativa*; Fig. 2. *Fagopyrum esculentum*; Fig. 3. *Triticum vulgare*; Fig. 4. *Vicia Faba*. Curves of daily changes of pH in the nutrient solutions which were renewed every 24 hours.

| | | | |
|---|---|---|---|
| ———— | NaNO$_3$-culture | ·············· | NH$_4$NO$_3$-culture |
| — — — | NH$_4$Cl-culture | — · — | (HN$_4$)$_2$SO$_4$-culture |
| ——··— | (NH$_4$)$_2$HPO$_4$-culture | ——···— | NH$_4$HCO$_3$-culture |

## TABLE   IV

*Vicia Faba*:   2 plants in each culture containing 40 cc. of nutrient solution.
Culture duration:   Sept. 14—21, 1924
Temp. 20°—25°C.

| N-source in the solution | pH | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial | Daily changes | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| NaNO$_3$ | 5.2 | 4.8 | 4.3 | 4.3 | 4.3 | 4.7 | 5.2 | 5.3 |
| NH$_4$NO$_3$ | 5.1 | 4.2 | 4.1 | 4.2 | 4.3 | 4.3 | 4.4 | 4.6 |
| NH$_4$Cl | 5.1 | 4.1 | 4.1 | 4.1 | 4.3 | 4.3 | 4.3 | 4.5 |
| (NH$_4$)$_2$SO$_4$ | 5.1 | 4.2 | 4.1 | 4.2 | 4.3 | 4.4 | 4.5 | 4.6 |
| (NH$_4$)$_2$HPO$_4$ | 6.9 | 6.3 | 6.2 | 6.4 | 6.6 | 6.6 | 6.6 | 6.7 |
| NH$_4$HCO | 7.8 | 7.0 | 7.0 | 7.4 | 7.3 | 7.5 | 7.5 | 7.6 |

From the results of the experiments described above, it will be seen that the manner and direction of the change of hydrogen ion concentration of the nutrient solutions were exactly the same as reported in previous papers (Loo, 1927-b, pp. 167—169), where no renewal of solution was made.   The hydrogen ion concentration of the nutrient solutions changed rapidly within 24 hours as a consequence of an unequal absorption of ions by the culture seedlings.   The solutions containing NH$_4$NO$_3$, NH$_4$Cl and (NH$_4$)$_2$SO$_4$ always became very acidic and those with (NH$_4$)$_2$HPO$_4$ as the nitrogen source remained almost constant.   The reaction of the solution containing NH$_4$HCO$_3$ changed but very slightly though in the cases of paddy rice and buckwheat it became very alkaline (Figs. 2 and 3).   The control solution containing NaNO$_3$ always became less acidic, though in the case of *Vicia Faba* a slight increase of hydrogen ion concentration was recognized within the first 5 days of the culture period.   The cause of this phenomenon,

as the writer has discussed in his previous paper (1927-b, p. 177), may be ascribed to the more rapid absorption of sodium or other cations.

No retardation of reaction change was secured through the renewal of the nutrient solutions. This may be explained by the fact that a small quantity of nutrient solutions was used. If culture vessels of larger capacity and sufficient nutrient solutions were used, or better, a continuous renewal of solution, such as worked out by TRELEASE and FREE (1922), ALLISON and SHIVE (1923) and recently by JOHNSON (1927), were accomplished, a better result would have been obtained. In fact, by using larger vessels which contain 400 cc. of nutrient solution, the author succeeded in retarding the change of reaction to a certain degree as will be shown in the next part of this paper.

But whether the change of the reaction or composition of a solution could be avoided by a special method of renewal is a matter of question. ALLISON and SHIVE, using a special apparatus for continuous renewal of culture solution, which supplied one litre of new solution to a culture during each 24 hours period, found that a constant driping of solution was by no means an effective method of controlling reaction change. In these experiments, iron was added to the nutrient solutions in different forms; namely: ferric chloride, ferrous and ferric sulphate. JONES and SHIVE (1922-a) found that in some modified TOTTINGHAM solutions which contain ammonium sulphate as the source of nitrogen, to which iron was added in the form of ferric sulphate, a good plant growth was secured, while even a trace of ferrous sulphate in the same solution produced a condition very toxic to the plants. In other publications (1921, 1922-b), these authors found the iron of ferric phosphate to be more easily available to the plants than that of ferrous sulphate. As far as the above experiments show, no difference in value could be found among the salts of iron, when they exist as only a trace in the solution.

## Comparative Studies of the Effects of the Renewed and Non-renewed Solutions upon the Growth of Culture Plants

The purpose of the following experiments was to study the effect of renewal of solution upon the growth of seedlings. PRIANISCHNIKOW (1924, 1926) used this method for prevention of physiological acidity

of $(NH_4)_2SO_4$. ALLISON and SHIVE (1923) found that continuous renewal of nutrient solutions considerably retarded reaction change. Though these authors did not regard it as an effective method for controlling the influence of the plants upon reaction, it may be expected that the unfavorable effect of change of hydrogen ion concentration on the plant growth may be lessened to some extent by the renewal of the nutrient solution.

Intermittent renewal of solutions was carried out every 24 hours. The desirability of a continuous flow of solution, as discussed by TRELEASE and LIVINGSTON (1922), is unquestionable. By using infinitely large vessels, and a small number of seedlings, a solution of constant reaction may logically be secured, but practically it is difficult to keep the reaction constant, as shown by ALLISON and SHIVE, and impracticable in our experimental work which involved a large series of culture solutions.

As culture vessels porcelain jars of a capacity of 400 cc. were used throughout. A series of control cultures was also carried out side by side in which no renewal of solution was made during the experiment. Duplicate cultures were employed in both series. The pH change in the solutions of the renewed series was recorded at the time of renewal. The composition and concentration of the nutrient solutions were as follows :

| | |
|---|---:|
| Stock solution A . . . . . . . . . . | 50 cc. |
| Stock Solution B . . . . . . . . . . | 50 cc. |
| Distilled water . . . . . . . . . . | 1900 cc. |
| Sum . . . . . . . . . . . . . | 2000 cc. |

Iron was added in the form of ferric chloride, two drops of a 2% solution to every litre of nutrient solution.

These experiments lasted 3—4 weeks. At the end of each experiment the length of shoot and root was measured and the seedlings were dried in a dry oven (about 80°C.) for 2 days and the dry weight of shoot and root was estimated. As the criterion of growth, stress is laid on the dry weight.

All the experiments were conducted in the greenhouse.

## 5. *Triticum vulgare*, "Martins Amber"

One week after the beginning of the experiment, symptoms of injury due to high acidity, such as red color in roots, was recognized in the plants grown in the $NH_4Cl$- and $(NH_4)_2SO_4$-cultures of the control series. A week later, plants in these cultures made no growth at all and their roots were about to decay. But no such symptom was seen on the leaves or on the roots of the seedlings grown in the solutions of the same composition which were renewed intermittently. However, the growth feature of the root system of the plants in the renewed series was just the same as in the case where no renewal of nutrient solutions was practised. The roots of plants in the $NaNO_3$-, $(NH_4)_2$-$HPO_4$- and $NH_4HCO_3$-cultures were long and fine and covered thickly with root hairs. In solutions with $NH_4Cl$ or $(NH_4)_2SO_4$ as the source of nitrogen, the roots were short and stubby. In general, the growth feature of the plants grown in the renewed series was more or less better than that in the cultures where no renewal of solution was made.

A glance at Table V will make clear the fact that only a slight retardation of increasing acidity in the $NH_4NO_3$-, $NH_4Cl$- and $(NH_4)_2$-$SO_4$-cultures was secured by renewal of the solution. But even this slight retardation improved the growth of seedlings; both the dry weight and length of shoot and root increased to some extent. The most interesting case could be seen in the $(NH_4)_2HPO_4$-culture where the effect of renewal of solution is most discernible. The reaction of the solution in question whose pH-value was 6.8, changed in the unrenewed series to pH 3.6 after two weeks and became 3.2 at the end of the experiment. On the other hand, by renewing the solution every 24 hours, the reaction of this solution was kept almost constant during the first two weeks and changed very little in the remainder of the experiment. The dry weight of shoot and root of the plants in the renewed series was almost twice that of those in the control series. Another noteworthy case is that of the $NH_4HCO_3$-culture, where no difference in reaction change between the renewed and control series was recognized. The dry weights of the plants in both series were almost equal to each other. As indicated in the writer's previous work (1927-b, p. 188), the favorable pH-range for the growth of wheat is between 6.8 and 5.0, therefore it is rather a matter of course that the renewal of solutions containing $NaNO_3$, $NH_4H_2PO_4$ and $(NH_4)_2HPO_4$ as source of nitrogen increased the dry weight, while the same treatment in the $NH_4HCO_3$-culture gave no better results.

## TABLE V

*Triticum vulgare:* 6 plants in each culture containing 400 cc. of nutrient solution.
Culture duration: June 28—July 22, 1926. Temp. 20°–30°C.

| N-source in the solution | | Initial | pH Daily changes (1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 32) | final | Dry weight (gm.) shoot | root | Length (cm.) shoot | root |
|---|---|---|---|---|---|---|---|---|
| NaNO₃ | renewed | 5.2 | 5.1 5.4 5.4 5.6 5.6 5.8 5.8 5.4 5.6 5.7 5.8 5.9 6.0 6.2 6.0 6.0 6.0 6.0 5.7 5.7 | 5.7 | 0.6660 | 0.1495 | 45 | 25 |
| | no renewal | 5.2 | 7.0 | 7.1 | 0.4248 | 0.1120 | 35 | 25 |
| NH₄NO₃ | renewed | 5.1 | 4.3 3.9 3.8 3.8 3.9 4.0 4.2 4.2 4.2 4.0 3.9 3.9 3.8 3.8 3.8 3.7 4.0 3.8 3.8 3.8 | 4.1 | 0.5785 | 0.1125 | 46 | 17 |
| | no renewal | 5.1 | 3.3 3.3 | 4.2 | 0.3118 | 0.0768 | 35 | 10 |
| NH₄Cl | renewed | 5.2 | 4.4 3.8 3.7 3.6 3.4 3.4 3.7 3.7 3.6 3.7 3.7 3.7 3.5 3.7 3.7 3.7 3.7 3.4 3.7 3.7 | 3.8 | 0.3263 | 0.0867 | 37 | 10 |
| | no renewal | 5.2 | 2.8 | 3.0 | 0.2015 | 0.0247 | 27 | 9 |
| (NH₄)₂SO₄ | renewed | 5.2 | 4.4 3.9 3.7 3.6 3.6 3.4 3.8 3.8 3.7 3.7 3.8 3.8 3.7 3.8 3.8 3.8 3.7 3.5 3.8 3.8 | 3.8 | 0.3085 | 0.0957 | 37 | 12 |
| | no renewal | 5.2 | 3.0 | 3.0 | 0.1933 | 0.0332 | 29 | 9 |
| NH₄H₂PO₄ | renewed | 5.4 | 5.3 5.1 4.8 4.6 4.1 5.1 5.3 5.3 4.8 4.6 4.6 4.6 4.0 4.0 3.8 4.7 5.2 4.4 4.2 | 3.9 | 0.5273 | 0.1185 | 45 | 20 |
| | no renewal | 5.4 | 3.1 | 3.1 | 0.2245 | 0.0338 | 33 | 10 |
| (NH₄)₂HPO₄ | renewed | 6.8 | 6.7 6.6 6.6 6.6 6.6 6.6 6.6 6.7 6.2 6.5 6.5 6.1 6.3 6.3 6.4 6.6 6.4 | 6.5 | 0.6150 | 0.1178 | 42 | 18 |
| | no renewal | 6.8 | 3.6 | 5.2 | 0.3968 | 0.0508 | 40 | 18 |
| NH₄HCO₃ | renewed | 8.4 | 8.1 7.8 7.8 7.6 7.6 7.8 7.8 7.7 7.7 7.6 7.5 7.7 7.8 7.8 8.0 8.2 | 8.2 | 0.3922 | 0.0618 | 30 | 8 |
| | no renewal | 8.4 | 7.6 | 7.3 | 0.3977 | 0.0565 | 34 | 9 |
| H₂O | renewed | 6.0 | 5.0 5.6 5.4 5.6 5.6 5.4 5.2 5.1 5.4 5.1 5.2 5.2 5.2 5.2 | 5.2 | 0.1445 | 0.0940 | 25 | 26 |
| | no renewal | 6.0 | 5.4 | 4.6 | 0.1160 | 0.0480 | 25 | 23 |

## TABLE VI

*Oryza sativa:* 6 plants in each culture containing 400 cc. of nutrient solution.
Culture duration: Aug. 1–20, 1926. Temp. 20°–25C°.

| N-source in the solution | | Initial | pH Daily changes | | | | | | | | | | | | | | | | Growth | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 11' | 12 | 13 | 16 | 17 | 18 | final | Dry weight (gm.) shoot | Dry weight (gm.) root | Length (cm.) shoot | Length (cm.) root |
| NaNO3 | renewed | 5.0 | 5.4 | 5.4 | 5.0 | 5.0 | 5.1 | 5.3 | 5.4 | 5.3 | 5.2 | 5.2 | 5.2 | 5.0 | 5.3 | 5.2 | 5.1 | 5.2 | 0.1000 | 0.0278 | 18.6 | 18.5 |
| | no renewal | 5.0 | | | | | | | | | | | | | | | | 6.4 | 0.0668 | 0.0220 | 13.0 | 18.5 |
| NH4NO3 | renewed | 5.0 | 4.1 | 4.2 | 4.1 | 4.0 | 4.3 | 4.1 | 4.0 | 4.0 | 4.2 | 4.2 | 4.4 | 4.5 | 4.0 | 4.4 | 4.2 | 4.5 | 0.1990 | 0.0318 | 27.6 | 14.5 |
| | no renewal | 5.0 | | | | | | | | | | | | | | | | 3.0 | 0.2204 | 0.0300 | 33.0 | 14.0 |
| NH4Cl | renewed | 5.0 | 3.9 | 3.8 | 3.8 | 3.8 | 3.9 | 3.8 | 3.5 | 3.8 | 3.8 | 3.8 | 4.0 | 4.2 | 3.5 | 4.0 | 3.9 | 4.1 | 0.2002 | 0.0338 | 31.0 | 14.0 |
| | no renewal | 5.0 | | | | | | | | | | | | | | | | 2.8 | 0.1478 | 0.0192 | 29.0 | 15.5 |
| (NH4)2SO4 | renewed | 5.0 | 3.9 | 3.9 | 3.8 | 3.9 | 3.8 | 3.8 | 3.6 | 3.7 | 3.9 | 3.8 | 3.9 | 4.1 | 3.5 | 4.0 | 3.8 | 4.2 | 0.2020 | 0.0330 | 34.2 | 14.5 |
| | no renewal | 5.0 | | | | | | | | | | | | | | | | 2.8 | 0.1555 | 0.0182 | 31.0 | 14.5 |
| NH4H2PO4 | renewed | 5.4 | 5.3 | 5.3 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 | 5.3 | 5.3 | 5.4 | 5.4 | 5.4 | 5.4 | 0.0640 | 0.0160 | 15.0 | 15.5 |
| | no renewal | 5.4 | | | | | | | | | | | | | | | | 3.8 | 0.0878 | 0.0220 | 23.0 | 13.5 |
| (NH4)2HPO4 | renewed | 6.8 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 0.0692 | 0.0212 | 14.0 | 15.0 |
| | no renewal | 6.8 | | | | | | | | | | | | | | | | 6.6 | 0.0550 | 0.0155 | 12.5 | 12.5 |
| NH4HCO3 | renewed | 7.6 | 8.4 | 8.2 | 8.0 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.0 | 8.0 | 8.0 | 8.0 | 8.6 | 8.4 | 8.0 | 8.0 | 0.0440 | 0.0115 | 10.5 | 14.5 |
| | no renewal | 7.6 | | | | | | | | | | | | | | | | 8.6 | 0.0465 | 0.0110 | 9.5 | 14.0 |
| H2O | renewed | 6.0 | 5.2 | 5.4 | 5.6 | 5.6 | 5.2 | 5.3 | 5.2 | 5.4 | 5.2 | 5.6 | 5.6 | 5.6 | 5.2 | 5.2 | 5.4 | 5.2 | 0.0470 | 0.0275 | 11.0 | 18.0 |
| | no renewal | 6.0 | | | | | | | | | | | | | | | | 5.0 | 0.0485 | 0.0215 | 10.4 | 17.0 |

### 6. *Oryza sativa*, "Akagé"

In the solutions containing $NH_4NO_3$, $NH_4Cl$ and $(NH_4)_2SO_4$, plants grew equally well in each of the two parallel series, though, at the end of the experiment, some symptoms of injuries due to high acidity occurred in the roots of the plants grown in the $NH_4Cl$- and $(NH_4)_2SO_4$-cultures, in which the solutions were not renewed. Chlorosis took place in the leaves of seedlings grown in the $NaNO_3$-culture of the non-renewed series. The plants in the other three series of cultures with $NH_4H_2PO_4$, $(NH_4)_2HPO_5$ and $NH_4HCO_3$ as nitrogen source showed unfavorable growth at the very outset of the experiment and became worse and worse as the experiment drew near the end. The peculiar whitening of leaves in the solutions containing ammonium phosphates and the stiffness of the shoot with its brown color in the $NH_4HCO_3$-culture came into appearance in the parallel series: these symptoms were rather deepened by the renewal of the solution.

Table VI shows the results of this experiment. From this Table, one can see that the degree of retardation of reaction change by the renewal of solution is in agreement with that of the previous experiment, but its effect upon plant growth is the reverse. In the cultures where the reaction of solution became more and more acidic, the more complete the retardation, the worse the plant growth. For example, as a result of renewal, the pH-values of the solutions containing $NaNO_3$, $NH_4H_2PO_4$, $(NH_4)_2HPO_4$ and $NH_4HCO_3$ remained almost constant, but the plant growth in these solutions was very poor in comparison with that in the $NH_4NO_3$-, $NH_4Cl$- and $(NH_4)_2SO_4$-cultures. Among these, the plant growth in the $NH_4N_2PO_4$-culture of the control series was comparatively better than that of the renewed series. Since the final pH of the $NH_4H_2PO_4$-culture of the control series was 3.8, the reaction of this solution should change very rapidly during the experiment. Therefore it is relatively well fitted for the growth of paddy rice plants which prefer a high acidity. In the solutions of the $NH_4Cl$- and $(NH_4)_2SO_4$-cultures, where the reaction became as acidic as pH 3.5 in 24 hours, the renewal of nutrient solution showed good results. But in the $NH_4NO_3$-culture, where the reaction changed more slowly than the just mentioned two, no better growth resulted from the renewal.

### 7. *Avena sativa*

The growth feature of the plants in the renewed series was in general better than that in the control series. In the $NH_4Cl$-, $(NH_4)_2$-

## TABLE VII

*Avena sativa*: 6 plants in each culture containing 400 cc. of nutrient solution.
Culture duration: Aug. 23—Sept. 13, 1926. Temp. 20°—25°C.

| N-source in the solution | | Initial | 1 | 2 | 3 | 4 | 5 | 7 | 9 | 11 | 12 | 14 | 15 | 16 | 17 | 18 | 19 | final | Dry weight (gm.) shoot | root | Length (cm.) shoot | root |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NaNO3 | renewed | 5.0 | 4.8 | 4.8 | 4.8 | 4.8 | 4.9 | 5.4 | 5.6 | 5.8 | 5.4 | 5.9 | 5.6 | 5.6 | 5.4 | 5.4 | 5.3 | 5.6 | 0.3692 | 0.0910 | 107 | 40 |
| | no renewal | 5.0 | | | | | | | | | | | | | | | | 7.2 | 0.3555 | 0.0665 | 113 | 42 |
| NH4NO3 | renewed | 5.0 | 4.0 | 4.0 | 4.3 | 4.6 | 4.2 | 4.6 | 4.6 | 4.2 | 4.6 | 4.2 | 4.4 | 4.3 | 4.6 | 4.7 | 4.6 | 4.5 | 0.4002 | 0.0702 | 122 | 31 |
| | no renewal | 5.0 | | | | | | | | | | | | | | | | 4.2 | 0.2708 | 0.0652 | 97 | 21 |
| NH4Cl | renewed | 5.0 | 3.8 | 3.7 | 4.1 | 4.4 | 4.0 | 3.7 | 3.6 | 3.4 | 3.8 | 3.4 | 3.5 | 3.5 | 3.8 | 4.0 | 3.8 | 3.5 | 0.2922 | 0.0625 | 102 | 20 |
| | no renewal | 5.0 | | | | | | | | | | | | | | | | 2.8 | 0.1690 | 0.0400 | 58 | 10 |
| (NH4)2SO4 | renewed | 5.0 | 3.8 | 3.8 | 4.2 | 4.4 | 4.1 | 3.7 | 3.6 | 3.4 | 3.9 | 3.4 | 3.5 | 3.5 | 3.7 | 3.0 | 3.7 | 3.6 | 0.2900 | 0.0665 | 98 | 20 |
| | no renewal | 5.0 | | | | | | | | | | | | | | | | 2.9 | 0.1700 | 0.0418 | 60 | 11 |
| NH4H2PO4 | renewed | 5.4 | 5.2 | 5.2 | 5.3 | 5.4 | 5.3 | 5.2 | 5.0 | 4.0 | 5.2 | 3.8 | 4.4 | 4.8 | 5.1 | 5.2 | 4.9 | 4.4 | 0.3853 | 0.0712 | 114 | 28 |
| | no renewal | 5.4 | | | | | | | | | | | | | | | | 3.0 | 0.2182 | 0.0542 | 74 | 20 |
| (NH4)2HPO4 | renewed | 6.8 | 6.7 | 6.7 | 6.8 | 6.8 | 6.8 | 6.7 | 6.6 | 6.6 | 6.8 | 6.4 | 6.6 | 6.6 | 6.6 | 6.7 | 6.6 | 6.6 | 0.3358 | 0.0585 | 114 | 27 |
| | no renewal | 6.8 | | | | | | | | | | | | | | | | 3.6 | 0.2705 | 0.0690 | 108 | 21 |
| NH4HCO3 | renewed | 7.6 | 8.0 | 8.0 | 8.0 | 8.1 | 8.1 | 8.4 | 8.4 | 8.4 | 8.0 | 8.5 | 8.2 | 8.1 | 8.2 | 8.2 | 8.2 | 8.4 | 0.0682 | 0.0145 | 33 | 5 |
| | no renewal | 7.6 | | | | | | | | | | | | | | | | 8.6 | 0.0485 | 0.0112 | 16 | 5 |
| H2O | renewed | 6.0 | 5.2 | 5.1 | 5.3 | 5.3 | 5.2 | 5.2 | 5.3 | 5.1 | 5.2 | 5.0 | 5.6 | 5.2 | 5.2 | 5.2 | 5.2 | 5.0 | 0.0810 | 0.0485 | 55 | 32 |
| | no renewal | 6.0 | | | | | | | | | | | | | | | | 4.4 | 0.0700 | 0.0315 | 45 | 25 |

## TABLE VIII

*Pisum sativum*: 3 plants in each culture containing 400 cc. of nutrient solution.
Culture duration: Sept. 24—Oct. 24, 1926. Temp. 15°—25°C.

| N-source in the solution | | pH | | | | | | | | | | | | | Growth | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Daily changes | | | | | | | | | | | | Dry weight (gm.) | | Length (cm.) | |
| | | Initial | 1 | 3 | 4 | 5 | 6 | 8 | 10 | 12 | 15 | 18 | 22 | final | shoot | root | shoot | root |
| NaNO$_3$ | renewed | 5.0 | 5.2 | 5.3 | 5.4 | 5.3 | 5.3 | 5.4 | 5.6 | 5.8 | 6.0 | 6.0 | 6.2 | 6.0 | 0.8770 | 0.1980 | 51 | 17 |
| | no renewal | 5.0 | | | | | | | | | | | | 7.0 | 0.7280 | 0.1418 | 38 | 14 |
| NH$_4$NO$_3$ | renewed | 5.0 | 4.1 | 3.9 | 4.0 | 4.2 | 4.1 | 3.9 | 3.9 | 3.7 | 3.7 | 3.6 | 3.8 | 3.8 | 0.8160 | 0.1242 | 49 | 14 |
| | no renewal | 5.0 | | | | | | | | | | | | 3.6 | 0.6650 | 0.1398 | 34 | 14 |
| NH$_4$Cl | renewed | 5.0 | 4.0 | 3.7 | 3.8 | 3.8 | 3.9 | 3.8 | 3.8 | 3.8 | 3.8 | 3.7 | 3.7 | 3.6 | 0.3030 | 0.1110 | 20 | 14 |
| | no renewal | 5.0 | | | | | | | | | | | | 3.4 | 0.1857 | 0.0957 | 20 | 12 |
| (NH$_4$)$_2$SO$_4$ | renewed | 5.0 | 4.0 | 3.7 | 3.7 | 3.8 | 3.8 | 3.7 | 3.7 | 3.7 | 3.4 | 3.4 | 3.6 | 3.8 | 0.4845 | 0.1407 | 30 | 14 |
| | no renewal | 5.0 | | | | | | | | | | | | 3.4 | 0.3107 | 0.0990 | 25 | 12 |
| NH$_4$H$_2$PO$_4$ | renewed | 5.4 | 5.1 | 4.4 | 5.1 | 5.4 | 5.1 | 4.7 | 4.1 | 3.9 | 3.7 | 3.5 | 3.5 | 4.0 | 0.6770 | 0.1430 | 40 | 14 |
| | no renewal | 5.4 | | | | | | | | | | | | 3.6 | 0.3760 | 0.1277 | 23 | 11 |
| (NH$_4$)$_2$HPO$_4$ | renewed | 6.8 | 6.6 | 6.5 | 6.6 | 6.6 | 6.6 | 6.6 | 6.6 | 6.4 | 6.1 | 6.0 | 5.8 | 6.2 | 0.7472 | 0.1832 | 38 | 13 |
| | no renewal | 6.8 | | | | | | | | | | | | 3.5 | 0.6975 | 0.1227 | 38 | 15 |
| NH$_4$HCO$_3$ | renewed | 7.6 | 7.5 | 7.6 | 7.6 | 7.6 | 6.7 | 7.4 | 7.6 | 7.5 | 7.6 | 7.4 | 7.4 | 7.4 | 0.5530 | 0.1330 | 30 | 11 |
| | no renewal | 7.6 | | | | | | | | | | | | 7.4 | 0.4812 | 0.1497 | 33 | 12 |
| H$_2$O | renewed | 6.0 | 5.0 | 5.0 | 5.0 | 5.0 | 4.8 | 4.8 | 4.8 | 4.6 | 4.6 | 4.8 | 4.8 | 4.6 | 0.3500 | 0.1425 | 26 | 16 |
| | no renewal | 6.0 | | | | | | | | | | | | 5.2 | 0.2185 | 0.0920 | 19 | 12 |

## TABLE IX

*Glycine Soya.*: 2 plants in each culture containing 400 cc. of nutrient solution.
Culture duration: Sept. 25—Oct. 18, 1926. Temp. 10°–20°C.

| N-source in the solution | | pH | | | | | | | | | | | | | Growth | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Initial | Daily changes | | | | | | | | | | | final | Dry weight (gm.) | | Length (cm.) | |
| | | | 2 | 3 | 4 | 5 | 7 | 9 | 11 | 14 | 17 | 21 | | | shoot | root | shoot | root |
| $NaNO_3$ | renewed | 5.0 | 5.1 | 4.9 | 4.8 | 4.8 | 4.8 | 4.7 | 4.7 | 5.4 | 5.7 | 5.8 | 5.6 | 0.5777 | 0.1000 | 28 | 12 |
| | no renewal | 5.0 | | | | | | | | | | | 5.4 | 0.5577 | 0.1122 | 28 | 15 |
| $NH_4NO_3$ | renewed | 5.0 | 4.4 | 4.4 | 4.3 | 4.3 | 4.1 | 3.8 | 3.8 | 3.9 | 4.0 | 4.8 | 4.9 | 0.5485 | 0.0957 | 29 | 13 |
| | no renewal | 5.0 | | | | | | | | | | | 4.4 | 0.5212 | 0.1065 | 29 | 12 |
| $NH_4Cl$ | renewed | 5.0 | 4.0 | 4.0 | 4.0 | 4.0 | 3.9 | 3.5 | 3.4 | 3.4 | 3.2 | 3.6 | 4.3 | 0.4095 | 0.0780 | 26 | 11 |
| | no renewal | 5.0 | | | | | | | | | | | 3.2 | 0.3745 | 0.0517 | 26 | 10 |
| $(NH_4)_2SO_4$ | renewed | 5.0 | 4.1 | 3.9 | 3.8 | 3.8 | 3.7 | 3.5 | 3.4 | 3.4 | 3.3 | 3.6 | 3.9 | 0.4675 | 0.0720 | 30 | 13 |
| | no renewal | 5.0 | | | | | | | | | | | 3.3 | 0.4047 | 0.0643 | 28 | 10 |
| $NH_4H_2PO_4$ | renewed | 5.4 | 5.2 | 5.4 | 5.4 | 5.3 | 4.8 | 3.8 | 3.6 | 3.6 | 3.7 | 3.7 | 4.2 | 0.5350 | 0.1182 | 27 | 14 |
| | no renewal | 5.4 | | | | | | | | | | | 3.2 | 0.3345 | 0.0675 | 28 | 12 |
| $(NH_4)_2HPO_4$ | renewed | 6.8 | 6.6 | 6.7 | 6.7 | 6.7 | 6.6 | 6.4 | 6.4 | 6.0 | 6.0 | 6.1 | 6.2 | 0.6835 | 0.1452 | 31 | 11 |
| | no renewal | 6.8 | | | | | | | | | | | 3.2 | 0.4988 | 0.0957 | 28 | 12 |
| $NH_4HCO_3$ | renewed | 7.6 | 8.0 | 7.8 | 7.8 | 7.8 | 7.7 | 8.0 | 8.0 | 7.9 | 7.7 | 7.6 | 7.6 | 0.4725 | 0.1365 | 27 | 10 |
| | no renewal | 7.6 | | | | | | | | | | | 8.0 | 0.4297 | 0.1080 | 25 | 7 |
| $H_2O$ | renewed | 6.0 | 5.2 | 5.0 | 5.2 | 5.0 | 5.0 | 5.0 | 5.0 | 4.8 | 4.6 | 4.6 | 4.8 | 0.4515 | 0.1445 | 23 | 12 |
| | no renewal | 6.0 | | | | | | | | | | | 5.6 | 0.3805 | 0.0775 | 27 | 11 |

$SO_4$- and $NH_4H_2PO_4$-cultures, where no renewal of solution was made, the appearance of the seedlings was not very sound and indeed a chlorotic symptom appeared in the new leaves. The seedlings in the $NH_4HCO_3$-culture of both series did not grow at all.

Table VII shows that the manner of retardation in reaction change and the effect of the renewal of solution were somewhat similar to that in the experiment with wheat. Here the growth of seedlings was improved more or less by the renewal of the solution in every culture. As the plants grown in the $NH_4NO_3$- and $NH_4H_2PO_4$-cultures of the renewed series got the greatest dry weight, the favorable pH-range for the growth of oats may lie on the more acid side than that for wheat, perhaps between pH 4.5 and 5.5. The alkalinity of the $NH_4HCO_3$-culture is toxic to the growth of this seedling. Therefore no better results could be expected from the renewal of solution.

## 8.  *Pisum sativum*

In this experiment, there was marked difference between the control and renewed series in respect to color of the root system. Generally speaking, the root system in the solutions which were ren. wed intermittently was white in color, though those in the $NH_4Cl$-, $(NH_4)_2SO_4$- and $NH_4NO_3$-cultures were yellowish gray. The color of the roots in the $NaNO_3$-, $NH_4NO_3$-, $(NH_4)_2HPO_4$- and $NH_4H_2PO_4$-cultures of the control series was yellowish white and that in the $NH_4Cl$- and $(NH_4)_2SO_4$-cultures of the same series was grayish black. In the solutions containing $NH_4HCO_3$, the root of the seedlings was black in color. The seedlings in the $NH_4Cl$- and $NH_4H_2PO_4$-cultures of the control series wilted at the end of the experiment. The renewal of solution in the $NH_4Cl$-culture could not prevent the seedlings from wilting, but in the $NH_4H_2PO_4$- culture, the growth was much improved by the treatment.

From Table VIII, it will be seen that, without any exception, the growth of the seedlings was improved to some extent by the renewal of the solution.

## 9.  *Glycine Soya*

Table IX gives the results of the experiment with soybeans. These results resemble the previous one in every respect, including the

growth feature of roots and other parts of the seedlings. From the fact that the best growth was secured in the $(NH_4)_2HPO_4$-culture of the renewed series and that the seedlings grew tolerably well in the solutions containing $NH_4HCO_3$, both renewed and non-renewed, we may conclude with reasonable safety that the optimum pH for soybean was near pH 6.0.

In this case, too, the growth of seedlings was improved by the renewal of the solutions.

The results of experiments 5–9 show in general the beneficial effect of the renewal of the solution. TOTTINGHAM and RANKEN (1922) growing wheat seedlings in SHIVE's solution $R_5C_2$, found that the plant growth in the continuously renewed solution was inferior to that in the solution with intermittent renewal. On the other hand, ALLISON and SHIVE (1923) found that solution cultures with continuous renewal always produced plants which were superior in every respect to those grown in the culture whose solution was renewed intermittently. As is obvious from our results the effect depends greatly upon the nature of culture seedlings and the manner of reaction change in the solution. The results of experiments 5 and 6 are a very good example of this statement. The reaction change of solutions of the renewal series were similar, but the effects of renewal were different. In Table X, the relative increase of dry weight of shoot and root grown in the $NH_4NO_3$-, $NH_4Cl$-, $(NH_4)_2SO_4$- and $NH_4H_2PO_4$-cultures of the renewed series is shown. These numbers were calculated from Tables V and VI, taking the dry weight of the plants in each culture of the control series respectively as 100.

## TABLE X

| Culture solutions | Oryza sativa | | Triticum vulgare | |
|---|---|---|---|---|
| | shoot | root | shoot | root |
| $NH_4NO_3$ | 90 | 106 | 185 | 148 |
| $NH_4Cl$ | 135 | 176 | 162 | 351 |
| $(NH_4)_2SO_4$ | 136 | 181 | 160 | 290 |
| $NH_4H_2PO_4$ | 72 | 73 | 235 | 351 |

It is clear from this Table that in the case of *Oryza sativa,* no increase in yield was obtained by renewal of solutions containing $NH_4NO_3$ and $NH_4H_2PO_4$ in which the reaction change was more or less retarded. On the other hand, great increase of dry weight was produced by the renewal in the $NH_4Cl$- and $(NH_4)_2SO_4$-cultures whose acidity became very great at the time of the renewal. The relation is the opposite with wheat. Thus the effect of renewal of solution may be favorable to the growth of one plant but unfavorable to another.

By renewal of nutrient solution we can to some extent prevent the reaction change of a solution. Therefore its effect is somewhat similar to that of buffer action in a wide sense. In the discussion of the effect of buffer action (1927-b, p. 192), the writer has noted that the solution with strong buffer action is not the best culture medium, if the initial pH of that solution is not fit for the growth of the plant. This relation holds good in the case of renewal of solution too. If the initial pH of the solution is not suitable to the culture plant, no better results could be expected from the effect of renewal. In fact, the renewal of the $NH_4HCO_3$-culture produced no increase of yield in any case.

Thus in speaking of the effect of renewal of solution, the initial pH, manner of reaction change, as well as special behavior of culture plants towards acidity should always be taken into consideration.

## The Effect of Aëration of Nutrient Solutions upon the Growth of Plants

The results of the experiments mentioned above ascertained the beneficial effect of renewal of solution and the important rôle of reaction change. Another point that deserves further consideration is the relation of aëration to the renewal of solution. The oxygen relation in water culture is considered to be very poor. The amount of oxygen which dissolves in culture solution will be consumed after contact with the root system of seedlings, and instead of it, the carbon dioxide will rapidly increase as the result of respiration. This accumulation of carbon dioxide together with the scarcity of oxygen may exert an ill effect on plant growth. Consequently the removal of this ill action ought to account for one of the causes of the beneficial effect of solution renewal. On the other hand, authors who do not accept the fact of

unequal absorption of ions by plants are accustomed to ascribe the accumulation of carbon dioxide as the cause of the increasing acidity of the solution.  Therefore it is necessary to examine whether driving out the carbon dioxide through aëration brings any good results on the plant growth or whether it has anything to do with the change of reaction in the culture solution.

For this purpose a number of experiments were carried out with wheat, rice, oats and peas.  Out of seven kinds of nutrient solutions used in the foregoing experiments, three were chosen as culture media.

| Culture No. | N-source |
|---|---|
| 1 | $(NH_4)_2SO_4$ |
| 2 | $NaNO_3$ |
| 3 | $NH_4HCO_3$ |

The composition of the solutions was as follows:

| | |
|---|---|
| Stock solution A | 75 cc. |
| Stock solution B | 75 cc. |
| $FeCl_3$ | trace |
| Distilled water | 1350 cc. |
| Sum | 1500 cc. |

Jena glass tall beakers  containing 300 cc. of nutrient solution were used as culture vessels.  All the cultures were triplicated except in the experiments with rice and wheat, in which only duplicates were worked out in the control (without aëration) series.  All the experiments were conducted in the greenhouse.  No renewal of solution was practised during the experiment.

Aëration was accomplished by passing the $CO_2$-free air through the solution three times a day with the help of a double spraybulb. The duration of aëration was 4 minutes each time.  The text-figure 5 shows the diagrammatic scheme of the method of aëration.
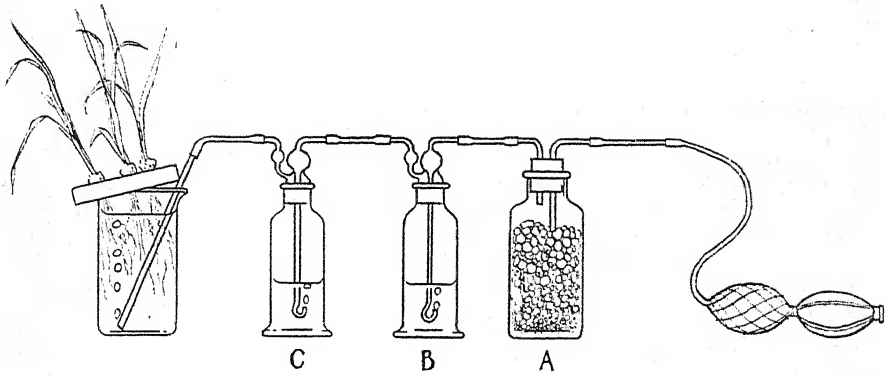
Fig. 5.  Diagrammatic scheme showing the method of aëration.  A, soda lime;
B, distilled water; C, redistilled water with few drops of phenol
red.  That the air passed through A and B was free from $CO_2$ was
ascertained by the color of phenol red in C.

## 10.  *Oryza sativa*, " Akagé "

### TABLE  XI

*Oryza sativa*:  6 plants in each culture containing 300 cc. of nutrient
solution.  Culture duration: July 6—17, 1926.  Temp. 20°—30°C.

| N-source in solution | | Dry weight (gm.) | | | Length (cm.) | | pH | |
|---|---|---|---|---|---|---|---|---|
| | | shoot | root | total | shoot | root | initial | final |
| $(NH_4)_2SO_4$ | aërated | 0.0753 | 0.0230 | 0.0983 | 18.3 | 16.3 | 5.1 | 3.4 |
| | not aërated | 0.0765 | 0.0255 | 0.1020 | 18.0 | 17.2 | 5.1 | 3.2 |
| $NaNO_3$ | aërated | 0.0612 | 0.0310 | 0.0922 | 12.5 | 18.0 | 5.2 | 6.4 |
| | not aërated | 0.0627 | 0.0305 | 0.0932 | 12.5 | 16.0 | 5.2 | 6.4 |
| $NH_4HCO_3$ | aërated | 0.0427 | 0.0228 | 0.0655 | 11.0 | 16.4 | 7.6 | 8.6 |
| | not aërated | 0.0435 | 0.0240 | 0.0675 | 10.0 | 16.5 | 7.6 | 8.7 |

Table XI shows the length and dry weight of the plants.  It is
clear from this Table that no beneficial effect upon the growth of the
seedlings was accomplished by aëration of the solution.  The dry

weight of shoot and root was almost equal in both series.  Examination of pH changes of the solution shows no difference in reaction change between the cultures of the same nitrogen source.

### 11.  *Triticum vulgare*, "Martins Amber"

The results of this experiment are summarized in Table XII.  As in the previous experiment, no marked difference in growth and in reaction change was to be seen.  In the $NaNO_3$-culture, the growth of the plants in the aërated series was a little better than that of the control series, especially the growth of the root.  It is interesting to see that the dry weights of both shoot and root of the plants grown in the non-aërated $NH_4HCO_3$-culture, are greater than these of the aërated culture.  As $NH_4HCO_3$ is an unstable compound, $CO_2$ will be set free from it by aëration, leaving the solution more alkaline   This great alkalinity must exert an ill effect on the growth of seedlings.  Indeed, we found that the final pH of this solution was 8.5, while that of the control series was 8.0.

### TABLE  XII

*Triticum vulgare:* 6 plants in each culture containing 300 cc. of nutrient solution.  Culture duration: Aug. 7—30, 1926.  Temp. 20°—25°C.

| N-source in solution | | Dry weight (gm.) | | | Length (cm.) | | pH | |
|---|---|---|---|---|---|---|---|---|
| | | shoot | root | total | shoot | root | initial | final |
| $(NH_4)_2SO_4$ | aërated | 0.1598 | 0.0400 | 0.1998 | 25.3 | 10.0 | 5.1 | 3.2 |
| | not aërated | 0.1598 | 0.0383 | 0.1981 | 26.1 | 10.0 | 5.1 | 3.3 |
| $NaNO_3$ | aërated | 0.3495 | 0.0740 | 0.4235 | 38.0 | 27.0 | 5.2 | 7.5 |
| | not aërated | 0.3448 | 0.0665 | 0.4113 | 39.1 | 27.0 | 5.2 | 7.3 |
| $NH_4HCO_3$ | aërated | 0.2228 | 0.0240 | 0.2468 | 29.3 | 5.0 | 7.6 | 8.5 |
| | not aërated | 0.2977 | 0.0370 | 0.3347 | 30.0 | 9.3 | 7.6 | 8.0 |

### 12.  *Phaseolous radiatus* L. var *aurea* PRAIN[1]

As is obvious from Table XIII, no influence of aëration is observed.  The dry weight of the shoot of seedlings in the $NaNO_3$-culture of the aërated series is superior to that of the control series, though the growth of root system showed no difference between these two series.

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(1)  In the writer's previous paper, "*P. Mungo* var. *subtrilobata*" was used as the species name of Azuki-bean.

The reaction change of the solution is exactly the same in both cases of the aërated and control culture.

## TABLE XIII

*Phaseolus radiatus* L. var. *aurea* PRAIN: 3 plants in each culture containing 300 cc. of nutrient solution. Culture duration: Aug. 21—Sept. 13, 1926 Temp. 20°—25°C.

| N-source in solution | | Dry weight (gm.) | | | Length (cm.) | | pH | |
|---|---|---|---|---|---|---|---|---|
| | | shoot | root | total | shoot | root | initial | final |
| $(NH_4)_2SO_4$ | aërated | 0.3120 | 0.0345 | 0.3465 | 23.7 | 8.3 | 5.1 | 3.2 |
| | not aërated | 0.3148 | 0.0340 | 0.3488 | 24.0 | 7.9 | 5.1 | 3.3 |
| $NaNO_3$ | aërated | 0.4688 | 0.0525 | 0.5213 | 44.3 | 14.7 | 5.2 | 6.6 |
| | not aërated | 0.4403 | 0.0525 | 0.4933 | 42.0 | 15.7 | 5.2 | 5.6 |
| $NH_4HCO_3$ | aërated | 0.1410 | 0.0178 | 0.1588 | 15.0 | 3.0 | 7.6 | 8.2 |
| | not aërated | 0.1442 | 0.0172 | 0.1614 | 18.0 | 4.0 | 7.6 | 8.3 |

## 13. *Avena sativa*

Though the dry weight of shoot in the $NaNO_3$-culture of the aërated cultures is a little greater than that in the control culture, no superior growth in the root system was observed, which means that there was no remarkable influence of aëration. The total dry weight is almost equivalent between the control and aërated cultures.

## TABLE XIV

*Avena sativa :* 6 plants in each culture containing 300 cc. of nutrient solution. Culture duration: Nov. 20—Dec. 22, 1926. Temp. 15°—25°C.

| N-source in solution | | Dry weight (gm.) | | | Length (cm.) | | pH | |
|---|---|---|---|---|---|---|---|---|
| | | shoot | root | total | shoot | root | initial | final |
| $(NH_4)_2SO_4$ | aërated | 0.1988 | 0.0347 | 0.2335 | 30.0 | 12.0 | 5.1 | 3.0 |
| | not aërated | 0.2211 | 0.0288 | 0·2499 | 30.0 | 12.0 | 5.1 | 3·0 |
| $NaNO_3$ | aërated | 0.6052 | 0.1112 | 0.7164 | 48.0 | 22.0 | 5.2 | 7.2 |
| | not aërated | 0.5957 | 0.1233 | 0.7190 | 46.0 | 29.0 | 5.2 | 7.1 |
| $NH_4HCO_3$ | aërated | 0.0672 | 0.0077 | 0·0749 | 17.0 | 3.0 | 7.6 | 8.4 |
| | not aërated | 0.0633 | 0.0105 | 0.0738 | 16.0 | 5.0 | 7.6 | 8.4 |

Thus, on the whole, aëration of nutrient solution has neither effect on the growth of culture seedlings nor any influence on the reaction change. Our results agree with those of FREE (1917), PEMBER (1917) and ALLISON and SHIVE (1923).[1] FREE found that aëration had no influence on the growth of buckwheat grown in the solutions which were renewed intermittently. PEMBER, by renewing the culture solutions every two weeks, found that barley did not respond to aëration. ALLISON and SHIVE were able to show that aëration has no beneficial effect upon the growth of the plant (soybeans) except upon the development of root, if the culture solutions were not renewed continuously. In the series of continuous renewal, however, they found that aëration produced the far highest yields. In our cases the effect of aëration was very insignificant.

From the studies of the effect of aëration, it is clear that the beneficial results of solution renewal has no relation to aëration at all. That is to say, in our culture solution, oxygen supply is not predominant factor in the growth of plants as compared to the effect of hydrogen ion concentration.

## Discussion

In the study of the effect of renewal of solution, three points are worth consideration. Firstly, we can keep the reaction of a solution constant by renewal, and consequently the favorable pH for the growth of a special plant can be determined. The experimental data of the present studies show that though in the cultures containing $NH_4NO_3$, $NH_4Cl$ and $(NH_4)_2SO_4$, only a slight retardation of reaction change was accomplished by renewal, the reaction of the $NH_4H_2PO_4$- and $(NH_4)_2HPO_4$-cultures was kept fairly constant. By this method, the different behavior of wheat and paddy rice toward acidity, which had been proved in the writer's previous work, was ascertained once more.

Secondly, by continuous renewal of solution, the composition and concentration of culture solution can be kept almost unchanged. The important relation of composition and concentration of a solution to plant growth was emphasized by HOAGLAND (1919) and affirmed by

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(1) It is regretted that W. STILES and J. JÖRGENSEN's paper, "Observation on the influence of aëration of the nutrient solution in water culture experiment, with some remarks on the water culture method." (New Phytologist, Vol. 16, 1917), is not within the writer's reach, and therefore is not cited in this paper.

DUGGAR (1920). But it is beyond the scope of the present study to discuss this problem, consequently the writer has not concerned himself with it.

Thirdly and lastly the growth of culture plants can be improved by renewal of solution. The cause of these beneficial effects, perhaps, is not simple. In the first place, the amount of the nutrient constituent may be greater in the renewed cultures than in the unrenewed cultures. Moreover some toxic matters which may be excreted by the culture plants will be removed by the renewal of solutions. These may probably be the reasons for the beneficial effects of renewal. But that these are not the important factors is evident from the fact that in some solutions, for example, in the $NH_4HCO_3$-culture, renewal of solution brings rather worse results. Then the most noteworthy point in this relation is that, as the result of absorption of nutrients by plants, some change may happen in the solution which would retard the growth of plants. The driving out of accumulated carbon dioxide and the matter of oxygen supply have not much to do with the beneficial effect of renewal, as we have shown in the experiments of the aëration of the solutions. Therefore the predominant factor is the toxic effect of physiological acidity of the salts contained in the solution which is avoided to a certain degree by the renewal of the culture solution.

## Summary

1. Renewal of culture solution was carried out every 24 hours. The direction of the reaction change of the solution of the renewed series was exactly the same as in the solution which was not renewed.

2. In general, the change of reaction in the solution was retarded to some extent by renewal of solution and consequently this treatment produced better results in the growth of the culture plants.

3. In the solutions where no remarkable retardation of reaction change was secured by renewal, such as in the $NH_4Cl$- and $(NH_4)_2SO_4$-cultures, the increase in yield was not so much as in the cultures whose reaction was kept almost constant by the same treatment (except in the case of *Oryza sativa*).

4. The effect of renewal of solution on the growth of paddy rice seedlings was found to be different from that on the growth of wheat.

5. In the case of the $NH_4HCO_3$-culture, no beneficial effect of renewal of solution was found.

6. Aëration of nutrient solution has no influence on the growth of the seedlings. From this fact, it may be concluded that the oxygen supply may not be a predominant factor in the beneficial effects of the renewal of solution.

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# Leaf Blight of Eragrostis major Host.

## Caused by Ophiobolus Kusanoi n.sp., the Ascigerous Stage of a Helminthosporium

By Yosikazu NISIKADO

With Plates XI—XV

## I. Introduction

In June 1924, the writer's attention was called for the first time to a leaf blight disease of strong-scented love-grass (*Eragrostis major* HOST.) growing near Kurashiki. Microscopical examination showed that the lesions were caused by a certain species of *Helminthosporium*. Further investigation revealed that the fungus may develop the perfect stage belonging to the genus *Ophiobolus*.

Many species of *Helminthosporium* have been already described as parasitic on the grasses of the genus *Eragrostis*. But since the descriptions of some of these species are very incomplete the identification of the conidial stage of the present species with that of the species till now described is impossible. As to the perithecial stage, the writer was not able to find any descriptions which may be considered to refer to the fungus under consideration. Therefore the present fungus seemed to him to be a new species, and the name, *Ophiobolus Kusanoi* is proposed.

## II. Symptoms of the Disease

The present disease usually occurs in spring and autumn. At first small water-soaked-like lesions are produced, which then become grayish brown, and enlarge gradually in longitudinal direction. They are generally oblong and truncate at both ends, about 1 mm. in width and 10-15 mm. or sometimes more than 30 mm. in length. Some of

them coalese to each other, and become irregular in shape, and their margins are provided with yellowish haloes. The affected leaves perish gradually up downwards and all the leaves die and shrivel. In some of the large lesions, and on dead leaves, dark colored fruit bodies are produced (cf. Pl. XI, Fig. 1 and Pl. XII, Fig. 1).

On the leaf-sheath the discoloration due to the present fungus starts from the point of its connection with leaf-blade and the lesions enlarge downward gradually. Almost all the ears and glumes of the diseased plants are also infected, and covered with blackish fruit bodies, showing some resemblances to those affected by smut fungi.

## III. Morphology of the Causal Fungus

### 1. CONIDIAL STAGE

#### (a) *Conidiophores*

On the affected parts of the host plants numerous conidiophores are produced. The manner of the conidiophore production on the leaf-blades and the leaf-sheath is somewhat different.

On the leaf-blade conidiophores emerge generally from the stomata of the under side. They are in tufts, each of which contains 1-7 conidiophores, as shown in Table I which is the result of 200 measurements of conidiophore-tufts produced on diseased leaf blades.

TABLE I. Number of Conidiophores in one Tuft of *Ophiobolus Kusanoi* NISIKADO produced on Leaf-blades of *Eragrostis major* HOST.

| No. of conidiophores in one tuft | No. of tufts measured | Percentage | No. of conidiophores measured | Percentage |
|---|---|---|---|---|
| Single conidiophore | 31 | 15·2 | 31 | 6.3 |
| 2 conidiophores | 94 | 46.1 | 188 | 38.2 |
| 3        ,, | 60 | 29.4 | 180 | 36.6 |
| 4        ,, | 13 | 6.4 | 52 | 10.6 |
| 5        ,, | 4 | 2.0 | 20 | 4.1 |
| 6        ,, | 0 | 0 | 0 | 0 |
| 7        ,, | 1 | 0.5 | 7 | 1.8 |
| 14        ,, | 1 | 0.5 | 14 | 2.6 |
| Total . . . . . | 204 | 100 | 492 | 100 |

On the leaf-sheath conidiophores appear at first through water pores. As they emerge out forming large tufts, where their number varies from 7 to 30 for each such tufts may be seen with naked eye (Pl. XI, Fig. 1). Later they appear not only through the water-pores, but also through the stomata. In the latter case each tuft contains only 2-3 conidiophores, just as in that of leaf-blades, and exhibits no special features. Each conidiophore produces the first conidium at a distance of about 15-30 $\mu$ from its base, then it grows immediately beneath the joint of attachment of the conidium and produces the second one at a distance of 7-25 $\mu$ from the first. On each conidiophore 1-15, and in general 3-5 conidia are produced. Conidiophores are swollen at the scars as well as at the apex, resembling the head of a peg. They are dark olive, becoming lighter toward the apex, about 6.5-7.7 $\mu$ wide, 25-250 $\mu$ (generally 40-100 $\mu$) long and multiseptate. Scars or the points of attachments of conidia to the conidiophores are conspicuous and 5-5.5 $\mu$ in diameter (cf. Pl. XI, Fig. 2-3 and Pl. XII, Fig. 2).

## (b)  *Conidia*

In shape the conidia of the present fungus show some resemblance to those of *Helminthosporium nodulosum* Sacc. parasitic on *Eleusine indica* Gaertn., but they are somewhat shorter. They are obclavate or long elliptical, and widest at the point at a distance of one third of the conidial length from the base. The basal part of the conidia is of parabolic contour and tapering toward the apex, the apex being hemispherical. The hilum is comparatively small and 2.3-4 $\mu$ wide and somewhat inconspicuous. The conidia are dark olive in color, the basal cell being especially dark, and becoming gradually lighter toward the apex, which is almost hyaline. Not only at the apex, but also around the hilum of the base, small hyaline regions are seen, from which the germ tubes are destined to appear. The dark epispores are pretty thick and fragile, and the inner walls of the conidia emerge easily from the broken epispores as in the case of those of *Hel. sativum* P. K. & B. described by F. L. Stevens (1922) (cf. Pl. XI, Fig. 2-3 and Pl. XII, Fig. 2). The size of the conidia varies greatly according to the conditions under which they are produced. A few examples of the conidia measurements are given in the following tables:

TABLE II.  Variations of Conidial Length of *Ophiobolus Kusanoi*
NISIKADO produced on *Eragrostis major* HOST.

| Classes of conidial length in μ | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Frequency { I | 1 | 17 | 38 | 106 | 145 | 106 | 65 | 17 | 5 | 500 |
| II | — | 3 | 31 | 77 | 128 | 145 | 131 | 63 | 22 | 600 |
| Total | 1 | 20 | 69 | 183 | 273 | 251 | 196 | 80 | 27 | 1100 |

TABLE III.  Variations of Conidial Width of *Ophiobolus Kusanoi*
NISIKADO produced on *Eragrostis major* HOST.

| Classes of conidial width in μ | 10.2 | 11.5 | 12.8 | 14.0 | 15.3 | 16.6 | 17.9 | 19.1 | 20.4 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Frequency { I | — | 10 | 107 | 110 | 211 | 43 | 17 | 2 | — | 500 |
| II | 1 | 3 | 25 | 75 | 293 | 102 | 93 | 5 | 3 | 600 |
| Total | 1 | 13 | 132 | 185 | 504 | 145 | 110 | 7 | 3 | 1100 |

TABLE IV.  Variations of Conidial Septation of *Ophiobolus Kusanoi*
NISIKADO produced on *Eragrostis major* HOST.

| Classes of conidial septation | 1 | 2 | 3 | 4 | 5 | 6 | Total |
|---|---|---|---|---|---|---|---|
| Frequency { I | 1 | 18 | 254 | 209 | 18 | — | 500 |
| II | — | 1 | 136 | 426 | 32 | 5 | 600 |
| Total | 1 | 19 | 390 | 635 | 50 | 5 | 1100 |

From the data given in Tables II—IV, means, standard deviations and variation coefficients, together with the probable errors for length, width and septation were calculated.   They are given in Table V.

TABLE V. Constants for Length, Width and Septation of Conidia of
*Ophiobolus Kusanoi* NISIKADO produced on *Eragrostis major* HOST.

| | | No. of conidia measured | Range | Mode | Mean | Standard deviation | Variation coefficient |
|---|---|---|---|---|---|---|---|
| Length in μ | I | 500 | 25.50-66.30 | 43.35 | 43.37±0.22 | 7.18±0.15 | 15.82±0.35 |
| | II | 600 | 28.08-66.30 | 56.10 | 46.16±0.17 | 3.74±0.07 | 7.50±0.15 |
| | Total | 1100 | 25.50-66.30 | 45.90 | 44.89±0.11 | 5.61±0.08 | 12.50±0.18 |
| Width in μ | I | 500 | 11.48-19.13 | 15.30 | 14.61±0.04 | 1.48±0.03 | 10.15±0.02 |
| | II | 600 | 10.20-20.40 | 15.30 | 15.15±0.04 | 1.41±0.03 | 8.99±0.18 |
| | Total | 1100 | 10.20-20.40 | 15.30 | 14.90±0.03 | 1.44±0.02 | 9.67±0.14 |
| Septa-tion | I | 500 | 1 — 5 | 3 | 3.45±0.02 | 0.64±0.01 | 18.41±0.41 |
| | II | 600 | 2 — 6 | 4 | 3.18±0.02 | 0.55±0.01 | 13.13±0.26 |
| | Total | 1100 | 1 — 6 | 4 | 3.65±0.01 | 0.59±0.01 | 16.17±0.24 |

## 2. ASCIGEROUS STAGE

### (a) *Perithecia*

On the dead parts of *Eragrostis major* HOST., affected by the
fungus above described, and especially on the decayed portions of the
lower parts of leaf-sheath, perithecial bodies are sometimes observed.
Perithecia are comparatively large and may be perceptible to naked
eye. At first they are produced under the epidermis of the host tissues,
and later break out through the epidermis. As shown in the photo-
micrograph of Pl. XIV, Fig. 1, the perithecia are spherical in shape,
300-350 μ in diameter, and provided with a slightly protruded beak.
The perithecial walls are composed of pseudoparenchymatous tissues of
polygonal cells, which are 10-13 × 7-10 μ. The outer 2 or 3 layers of
the wall-cells are black or dark olive, and the inner layers colorless.
The contents of the perithecia are at first composed of colorless long
filamentous cells with granules, and after maturation, the asci are
formed therein.

### (b) *Asci*

Numerous asci are produced at the bottom of the perithecia. They
are hyaline, thin-walled, cylindrical or long clavate, with round apex,
slightly tapering toward the short stipitate base, 130-170 μ long and
14-18 μ wide. They contain generally 8 ascospores, which fill them
from the stipe to the apex. Before the discharge of the ascospores the
asci are usually more or less swollen (cf. Pl. XIII, and Pl. XIV, Fig. 1-2).

### (c) *Paraphyses*

In the perithecia numerous paraphyses are produced between the asci, although they are generally inconspicuous. Paraphyses are hyaline, slender, filamentous, 1.5-2.0 $\mu$ in diameter, and almost as long as the asci. They are usually multiseptate, and provided with somewhat pointed apex. Frequently they are branched.

### (d) *Ascospores*

Ascospores are colorless, thin-walled, filamentous, provided with 6—8 septa, where they are slightly constricted. Within the asci the ascospores are spirally twisted together 2-3-times. They are 140—170 $\mu$ in length, about 5 $\mu$ in width and covered with thin slimy sheath. After discharge from the asci, the ascospores are untwisted and dispersed. The ascospores may germinate readily, producing germ tubes from each of all their cells terminally or laterally. The germ tubes are 3—5 $\mu$ in diameter (cf. Pl. XIV, Fig. 3-4).

## IV. Relationship of the Conidial and the Ascigerous Stages as shown by Pure Cultures

As stated above, the conidia of a *Helminthosporium* type and the perithecia of an *Ophiobolus* stage were found side by side on one and the same lesion of an infected plant. Though this fact makes the near relation between both fruit bodies very probable, the writer was able to demonstrate further their relationship by the observation of the production of both types of spore forms in the pure culture from a single spore.

### 1. PRODUCTION OF CONIDIA OF HELMINTHOSPORIUM TYPE IN THE PURE CULTURES FROM A SINGLE ASCOSPORE OF OPHIOBOLUS

As the ascospores of the *Ophiobolus* under consideration, which were produced on the leaf lesions of *Eragrostis major* HOST., germinated readily, the writer was able to secure some strains of pure cultures originating from a single ascospore. The pure culture thus secured showed exactly the same type of growth and produced exactly the same type of conidiophores and conidia as were found on the cultures originating from conidia found on the host plant.

## 2. Production of ascospores of Ophiobolus type in the pure cultures from a single conidium of the Helminthosporium

Further the writer was able to observe the production of the perithecia of *Ophiobolus* type containing mature ascospores in the pure cultures from the *Helminthosporium* under consideration. The morphological characters of the ascigerous stage produced in the pure cultures will be briefly described, although they are similar to those found on the host plant.

A strain of *Helminthosporium* fungus was isolated in September 29, 1926, from a leaf lesion of *Eragrostis major* Host. The strain was transplanted on rice agar medium in October 2, 1926, and then the cultures were kept under a room temperature of $11-15°C$. In November 20, 1926, a copious formation of conidia together with some small black bodies among them was observed on the surface of the medium. By microscopical examination the small bodies were revealed to be the perithecia of *Ophiobolus* type, containing mature asci.

*Perithecia* are at first produced beneath the surface of the medium, and then about $1/2-1/3$ of the perithecial bodies become erumpent, with the growth of the perithecia. They are spherical in shape, $125-600 \mu$ in diameter, and $227.25 \mu$ in the average (30 measurements). Among them, however, the smaller ones are generally immature and contain no mature asci. Therefore the mature asci may be $300-600 \mu$ in diameter.

The outer layers of the perithecial walls are dark olive colored and the inner layers hyaline. The cells separated out from the disintegrated walls of perithecia are generally lemon-shaped, and appear like the spores of a certain fungus. Near the ends of the beaks they are provided with some bristle-like appendages. They are shown in the photomicrographs in Pl. XV, Fig. 1—2.

*Asci* are similar to those produced on the host plant, and copiously formed at the bottom of perithecia. They are clavate or cylindrical, curved towards one side, and provided with curved short stipe and round apex.

*Ascospores* are hyaline, thin-walled, filamentous, 4-5-septate and contain 2-5 olive-colored oil drops in each. They are twisted 1 to 2.5 times in helicoid manner. They seem to be about 132-163 $\mu$ long.

# V. Taxonomy of the Causal Fungus

## 1. Conidial Stage

The present writer searched for previous descriptions of a fungus of which the conidial stage may be identical with that of the fungus under consideration. Among the species of *Helminthosporium* parasitic on *Eragrostis major* Host., the following two species were described by C. Drechsler in 1923:

(1) *Helminthosporium rostratum* Drechsler (1923)
(2) *Helminthosporium leucostylum* Drechsler (1923).

The first species is parasitic on dead leaves of *Eragrostis major* Host. The conidia are long and rostrate, 32-184 $\mu$ long and 3-9-septate, and quite different from those of the writer's species.

The second species resembles the present fungus in the shape and size of the conidia. Further both species are very similar to each other in the shape of conidiophores. The conidiophores of the writer's species, however, are dark olive-colored, while those of Drechsler's species are hyaline or very light in color, the name *Helm. leucostylum* being given on this account. Drechsler gave no records about the infection of the spikelets of *Eragrostis major* Host. by *Helm. leucostylum*, while the writer's species does infect them. For these reasons, the present species can not be considered to be identical to the Drechsler's second species.

Besides these species there is *Helminthosporium hadrotrichoides* E. et E. on dead leaves of *Eragrostis major* Host. The fungus was reported by Ellis and Everhart (1888) from North America. According to the original description, this species shows some resemblance to the present species in the shape, size and color of the conidiophores. As to the conidia of this species, however, the description of Ellis and Everhart is very incomplete, for it runs as follows: "The conidia are clavate-obovate or clavate-cylindrical, yellowish brown." To the writer's regret, it is impossible to make any comparison.

Further two more species are known to infect the grasses of the genus *Eragrostis*, although they seem not to be *E. major* Host. They are *Helminthosporium geniculatum* Tracy et Earle and *Helm. Eragrostidis* P. Henn.

The former species was described by Tracy et Earle (1896) as being parasitic on the spikelets of *Eragrostis rachitricha* in North America. According to the result of comparison between the present fungus and *Helm. geniculatum* Tracy et Earle in the original description, the two are different in respect to the shape and dimension of the conidia, especially their width.

The latter species was found by P. Hennings (1908) on a specimen collected in Congo, Africa. According to the description quoted by Saccardo (1913) in the Sylloge Fungorum Vol. 22, *Helm. Eragrostidis* seems to be similar to the present species. The writer, however, has not yet read the original paper of P. Hennings, and besides the Saccardo's description is very short. So it is impossible to identify the species under consideration with *Helm. Eragrostidis* P. Henn. As to the specific identification of these two species, the writer wishes to make further communication in near future.

## 2. Ascigerous stage

In respect to the ascigerous stage of the fungi belonging to the genus *Helminthosporium*, 2 generic types are known up to the present time, (1) *Pleospora* or *Pyrenophora* type, with short fusiform, muriformly septated ascospores, and (2) *Ophiobolus* type, with long filiform, spirally twisted ascospores. Although the writer's species should belong to the latter type, the morphological characters are not strictly in accordance with the diagnosis of the genus *Ophiobolus*. However, in the absence of more appropriate genus for the fungus with helicoid ascospores, the writer's fungus is tentatively assigned to the genus *Ophiobolus*.

As to the species of the latter genus which may show some similarity to the writer's species, Drechsler (1925) gave a detailed review on almost all the species reported before. The other species that should be mentioned in this connection are *Ophiobolus heterostrophus* Drechsler and *Ophiobolus Miyabeanus* Ito et Kuribayashi.

*Ophiobolus heterostrophus* Drechsler (1925) differs evidently from the present species in the shape, size and septation of the conidia (cf. Nisikado and Miyake, 1926). Not only are they different as to the conidia, but also respecting the dimension of perithecia, asci and ascospores, and the number of ascospores in each ascus.

*O. Miyabeanus* ITO et KURIBAYASHI (1927) is also different from the writer's species, as the former much exceeds the latter in size and number of septa of conidia, (cf. NISIKADO and MIYAKE, 1922), and also in the dimension of perithecia, asci and ascospores.

As far as the writer is aware, the ascigerous stage of the present fungus has not been described yet before. Therefore a new name *Ophiobolus Kusanoi* is proposed for the fungus under consideration, in honor of Dr. Shunsuke KUSANO, Professor of the Imperial University of Tôkyô. The diagnosis runs as follows :

### *Ophiobolus Kusanoi* n. sp.

Attacking leaf-blades and leaf-sheaches of *Eragrostis major* HOST. Lesions on the leaf-blades at first greenish, water-soaked-like, later becoming brown, with yellowish margin, 10—15 mm. and rarely 30 mm. in length, and 2 mm. in width. In cases of severe attack whole plants becoming dead and dry.

Perithecia developing on dead tissues of the host plant of the preceding season ; at first sunken within the host tissues, later erumpent with short rostrate beak ; globose or subglobose, 300--350 μ in diameter. Wall of the perithecia consisting of pseudoparenchyma composed of polygonal or elliptical cells, each being 10-13 × 7-10 μ, the outer 2-3 layers consisting of the cells which are dark olive-colored or black.

Asci hyaline, thin-walled, cylindrical or long clavate, shortly stipitate, with round apex ; 130-170 μ long, 14-18 μ wide, containing 8 ascospores ; somewhat swelling before the discharge of the ascospores.

Paraphyses numerous, hyaline, slender, 1.5-2.0 μ wide, equalling the asci in length.

Ascospores hyaline, filamentous, thin-walled ; 140-170 μ long, about 5 μ wide, 6-8-septate ; usually constricted at the septum ; spirally arranged, each twisted 2-3-times ; germinating readily.

Conidiophores appearing singly or in tufts of 2-7 from stomata of dead part of leaf blades ; but on the leaf-sheaches in groups of 7-30 from water pores ; 25-250 μ (generally 40-100 μ) long, 6.5-7.7 μ wide, 1-5-septate, bearing 1-15 conidia (generally 3-5) ; producing the first conidium at a distance of 15-30 μ from the base ; somewhat swollen at the apex and at the scars.

Conidia thick-walled, dark-olive-colored with light-colored end-cells; short, obclavate, or long elliptical, widest at the part one third from the base; at the base showing parabolic contour; tapering toward the hemispherical apex; 25.5-66.3 $\mu$ (mean 43.35 ± 0.22 $\mu$) long, 11.5-19.1 $\mu$ (14.61 ± 0.04 $\mu$) wide, 1-5 (3.45 ± 0.02) septate. Hilum contained within the contour of the base inconspicuous, 2.5-4 $\mu$ wide. Germinating readily and producing 2 polar germ-tubes.

*Habitat.* Collected near Kurashiki (June and September 1924, 1925 and 1926.)

REMARKS. The conidial stage of this species resembles *Helminthosporium Eragrostidis* P. HENN.

## VI.  Inoculation Experiments

The fungus used for inoculations was grown on rice-decoction agar. The conidia were carefully scraped off into the dilute rice decoction and the suspension was poured through gauze. The conidia

TABLE VI.  Summary of Results of the Inoculation Experiments of Conidia of *Ophiobolus Kusanoi* NISIKADO.

| Name of plants inoculated | Japanese name | Results of the experiments |
|---|---|---|
| *Agropyrum semicostatum* NEES. | Kamozi-gusa | — |
| *Arundinella anomala* STEUD. | Toda-siba | — |
| *Briza minor* L. | Hime-kobansô | — |
| *Coix Lacryma-Jobi* L. | Zyuzu-dama | — |
| *Cynodon Dactylon* PERS. | Gyôgi-siba | — |
| *Eleusine indica* GAERTN. | Ohisiba | + |
| *Eragrostis ferruginea* BEAUV. | Kaze-kusa | — |
| *E. major* HOST. | Suzume-gaya | + |
| *E. pilosa* BEAUV. | Niwa-hokori | — |
| *Imperata arundinacea* CYR. | Tigaya | — |
| *Oryza sativa* L. | Ine | — |
| *Panicum Crus Galli* L. var. *submuticum* MEY. | No-bie | — |
| *P. sanguinale* L. | Mehi-ziwa | — |
| *Pennisetum purpurascens* MAK. | Tikara-siba | — |
| *Phalaris arundinacea* L. var. *genuina* HACK. | Kusa-yosi | — |
| *Setaria italica* BEAUV. | Awa | — |
| *S. viridis* BEAUV. | Enokoro-gusa | — |

thus secured were applied with a small hand sprayer.  After inocula-
tions, the plants were well moistened and kept under infection cages
for 2 or 3 days.

In Table VI (p. 109), the summary of results of the inoculation
experiments by a pure culture originating from the *Helminthosporium*
stage of *Ophiobolus Kusanoi* NISIKADO are given.  In this table the
(+) sign denotes the positive and the (−) sign the negative results.


## VII.  Summary

(1)  The results of the morphological studies on a *Helmintho-
sporium* fungus infecting *Eragrostis major* HOST., and on its perfect
stage belonging to the genus *Ophiobolus*, are described.

(2)  In each of the pure cultures originating from the *Helmintho-
sporium* type as well as the *Ophiobolus* type respectively the production
of both types of the spore forms was observed.  Thus the intimate
relation of these two spore forms has been duly proven.

(3)  The conidia are short obclavate, and germinate readily pro-
ducing the germ-tubes only from both ends.  The conidial stage of the
present fungus resembles *Helminthosporium Eragrostidis* P. HENN.,
although their identity remains yet undecided in this paper.

(4)  Since the ascigerous stage of this fungus seems to have been
not yet described, a new name *Ophiobolus Kusanoi* is proposed.

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# Explanation of Plates XI—XV

All figures refer to *Ophiobolus Kusanoi* NISIKADO

## PLATE XI

Fig. 1.  Portion of plant of *Eragrostis major* HOST., affected by *O. Kusanoi* NISIKADO, collected near Kurashiki in June 1924. Showing leaf lesions, affected glumes, withered leaves and affected leaf-sheaths with small blackish points composed of large tufts of conidiophores. (Magn. ca. 1.4×)

Fig. 2. and 3.  Conidia and conidiophores of *O. Kusanoi* produced on host leaves in nature. Photomicrographs. (Magn. ca. 400×)

## PLATE XII

Fig. 1.   A plant of *Eragrostis major* affected by *O. Kusanoi*, showing leaf
lesions and affected glumes.   ($\frac{1}{2}$ natural size)

Fig. 2.   Conidia and conidiophores of *O. Kusanoi*, produced on the host leaves in
nature.   (Magn. ca. 410×)

## PLATE XIII

Fig. 1.   Asci and ascospores of *O. Kusanoi* developed in a perithecium formed in
an infected leaf-sheath, collected near Kurashiki in November 1926.
Two groups of ascospores newly discharged from asci are also shown.
(Magn. ca. 410×)

Fig. 2.   Asci and ascospores of *O. Kusanoi* from the same material as above.
In the upper part is shown an ascospore germinating after 24 hours
incubation in distilled water at 20°C. (Magn. ca. 410×)

## PLATE XIV

Perithecial stage produced on a leaf-sheath of *Eragrostis major*, collected near
Kurashiki in November 1926.

Fig. 1.   Longitudinal section of a perithecium; and asci discharged from it.
(Magn. ca. 150×)

Fig. 2.   Asci and ascospores.   (Magn. ca. 350×)

Fig. 3.   Ascospores newly discharged from asci, showing the torsion of ascospores
in helicoid manner.   (Magn. ca. 370×)

Fig. 4.   Ascospores, 2 hours after the discharge from asci in water.   (Magn. ca.
370×)

## PLATE XV

Perithecial stage of the strain No. 175, produced in pure cultures on rice decoction
agar medium at a room temperature of 11-15°C.   The strain No. 175 was isolated on
October 29, 1926, from a single conidium of a *Helminthosporium* type produced on an
infected leaf of *Eragrostis major*.

Fig. 1.   Surface view of perithecia produced on rice agar medium, showing the
production of a few perithecia and many conidia of *Helminthosporium*
type.   (Magn. ca. 80×)

Fig. 2.   Side view of a perithecium produced in a culture, showing a beak
protruded from the main body.   Near the top of the beak it is
provided with many bristle-like appendages.   (Magn. ca. 220×)

Fig. 3.   Showing many cells separated from the disintegrated wall of a perithe-
cium produced in a culture.   (Magn. ca. 400×)

Fig. 4.   Showing the torsion of newly-discharged ascospores produced in a
culture.   (Magn. ca. 400×)

PLATE XXI



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PLATE XII



2

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PLATE XIII

PLATE XIV



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3



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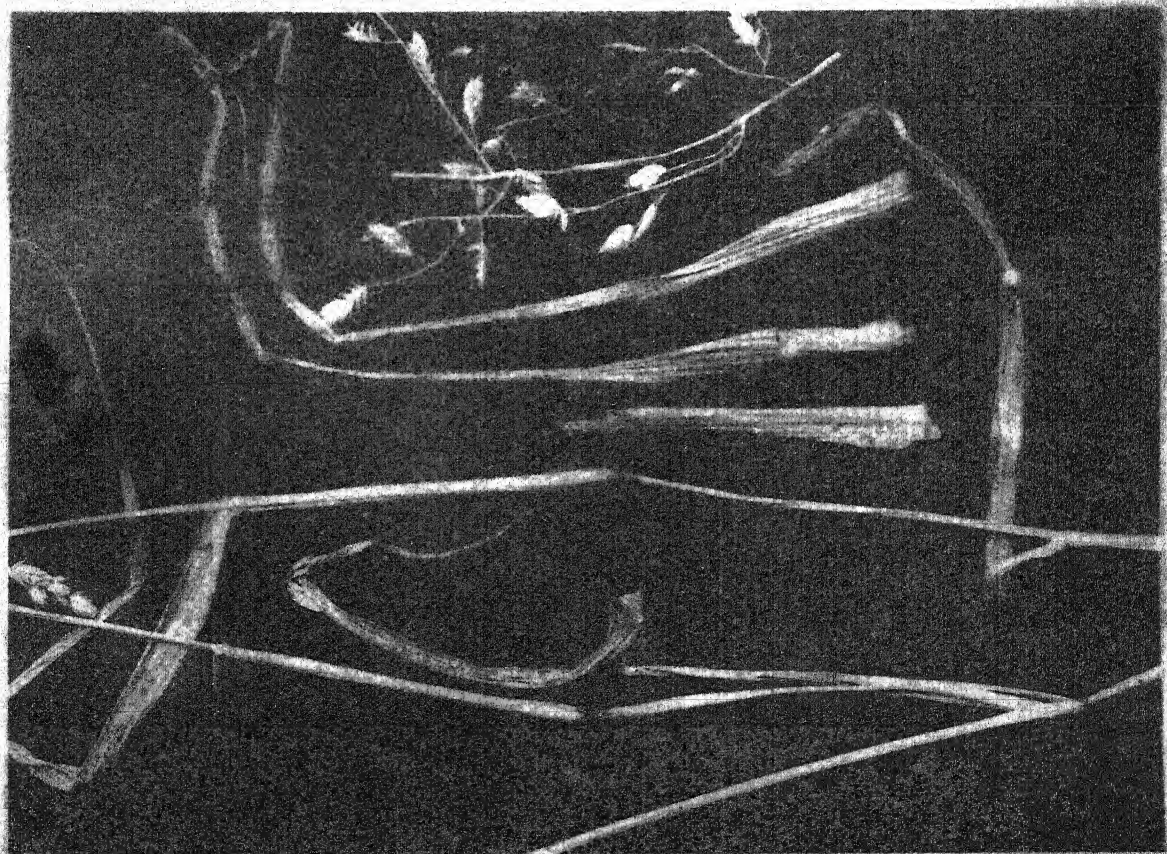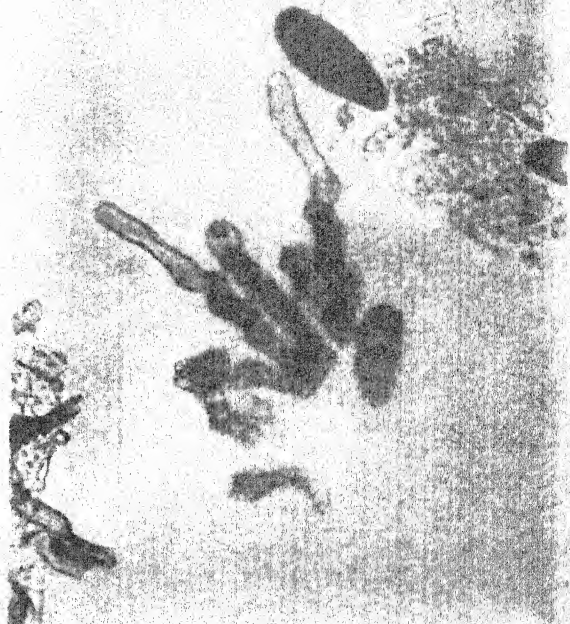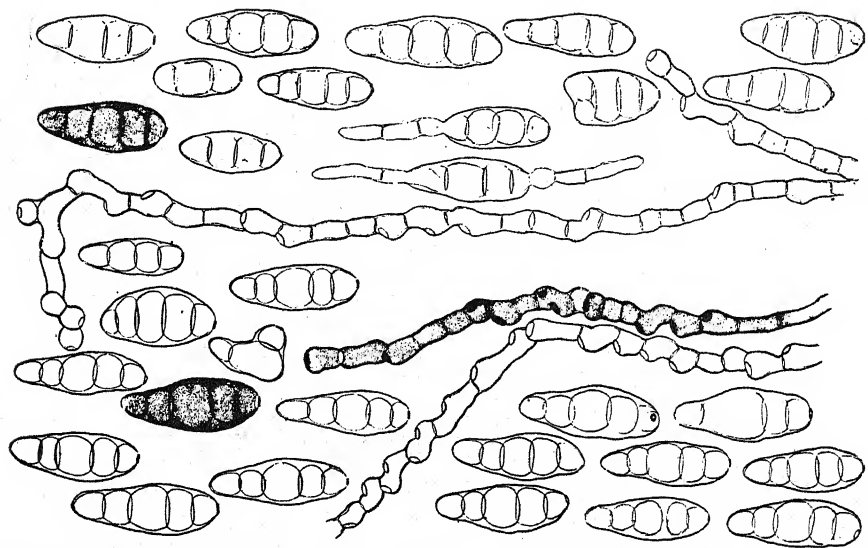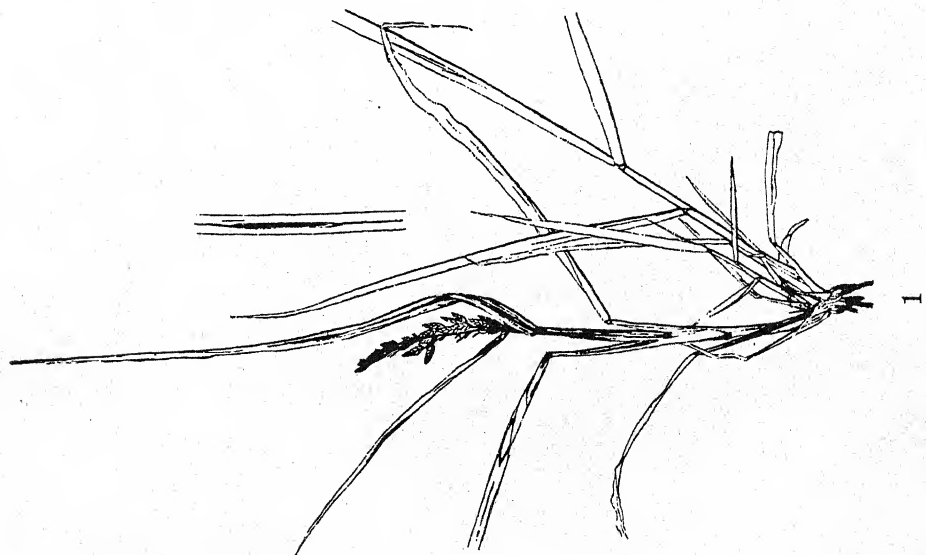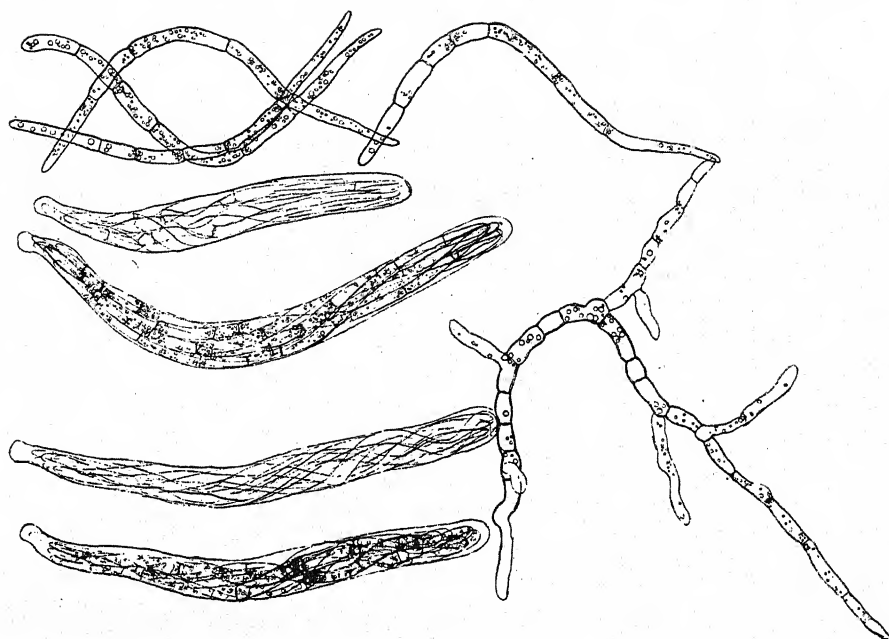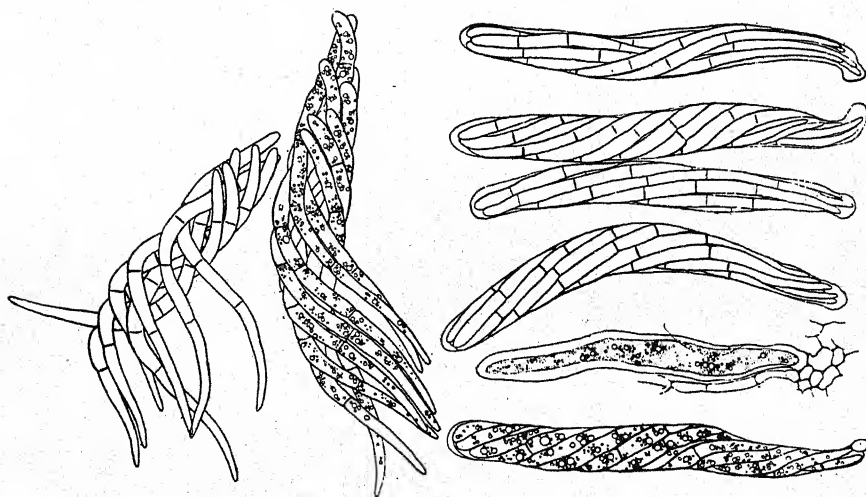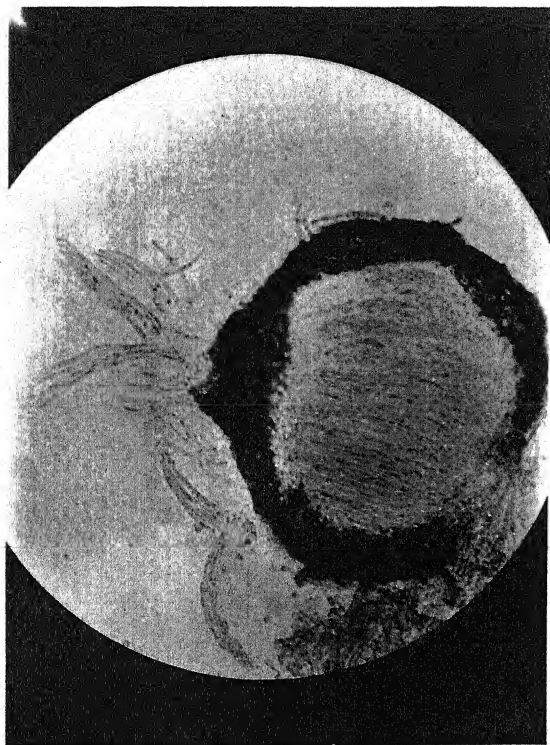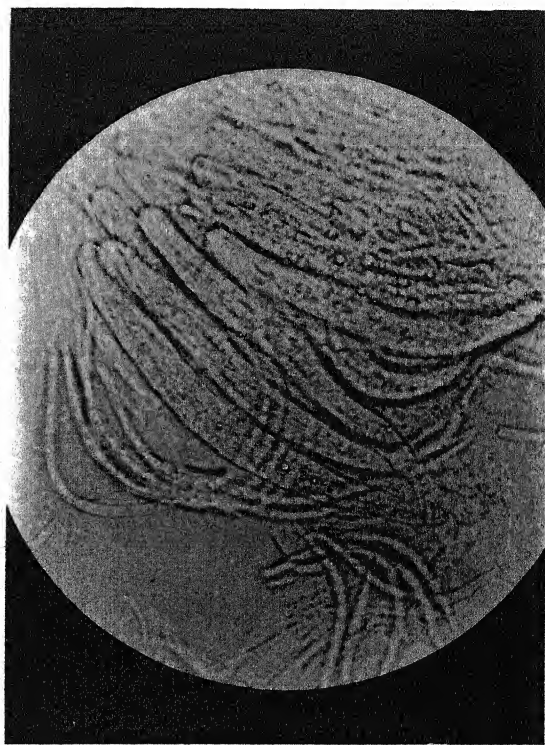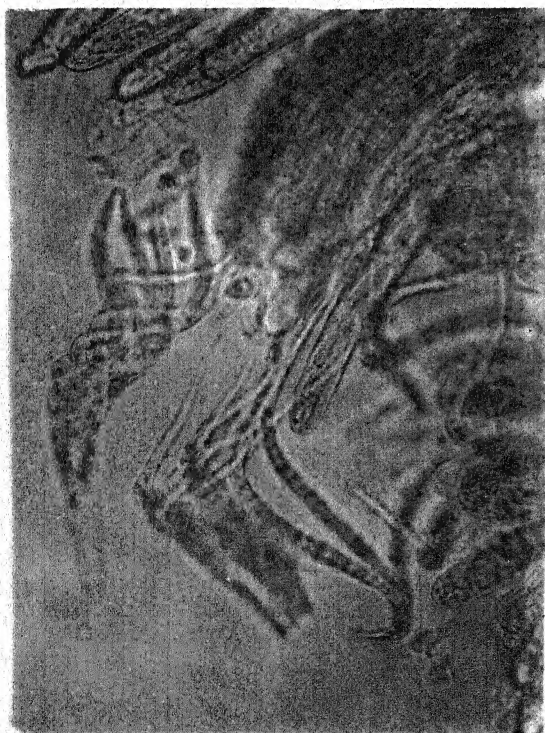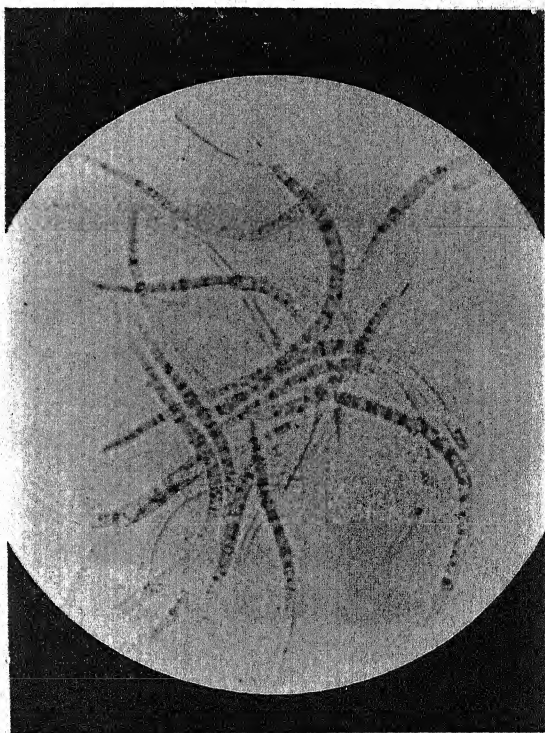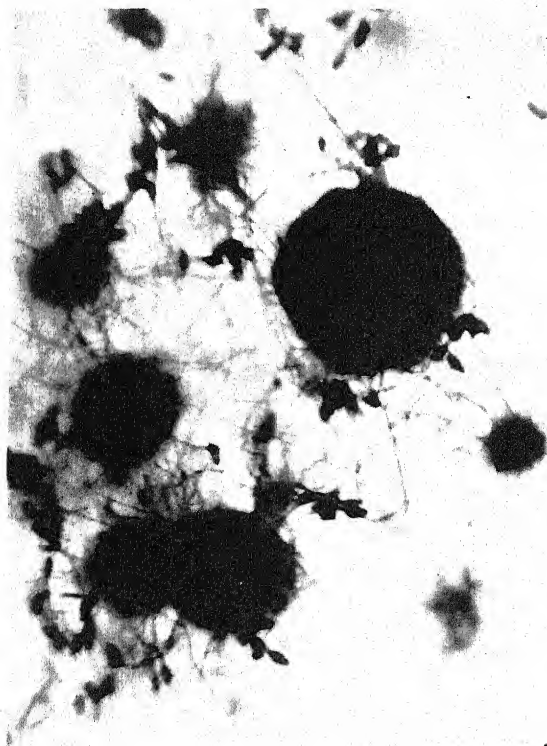
PLATE XV



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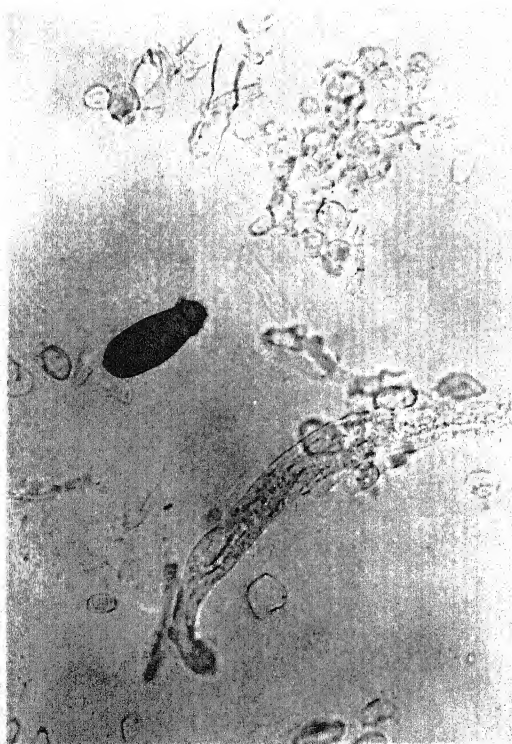
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4
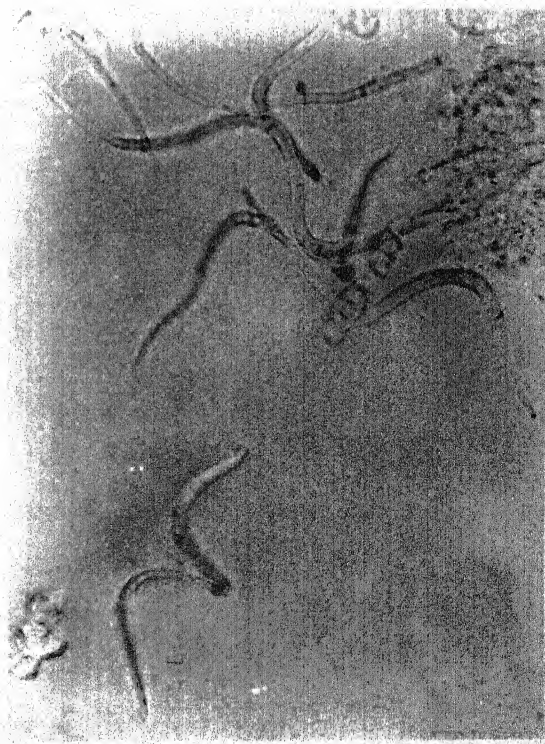
# An Outline of the Investigations on the Seed- and Seedling-rot of Rice caused by a Watermould, Achlya prolifera Nees

By Takewo HEMMI and Takuji ABE

## With Plate XVI

## Introduction

The rice to be transplanted is grown first in nursery-beds, the preparation of which is very important in obtaining strong and healthy plants. From the standpoint of agronomy the qualities of different kinds of nursery-beds have been discussed frequently. At the present time however nursery-beds covered with water are most commonly used in our country. Under the water the seeds and the young seedlings of the rice plant are very often attacked yearly by a watermould, causing serious damage. From Formosa to Hokkaido this rot disease is widely distributed and sometimes is so extensive as almost entirely to kill the plants grown in certain nursery-beds. *Achlya prolifera* (NEES) DE BARY has been generally considered as the primary cause of the disease according to SAWADA's investigation (13), although SUZUKI at first considered the disease as being caused by a bacterium. In literature this watermould is referred to under the name of *A. prolifera* (NEES) DE BARY or *A. prolifera* NEES (4-7). In 1888 DE BARY (6) used the former name in published writings, probably considering the latter to be a mixed species. ABE (1-2), the junior author of this paper, is now investigating the disease thoroughly and published two preliminary reports in 1927. The first report, in Japanese, on the results of his investigations in detail is recently out (3). Reviewing carefully the previous papers on this fungus, he came to the conclusion that with our present knowledge it is most reasonable to use the name *Achlya prolifera* NEES. The present paper gives an outline of the results of his experimental studies.

## Pure Cultures of the Causal Fungus

Pure cultures of the causal fungus were readily obtained by the plate-culture method, using 1% peptone agar.   After being washed thoroughly with sterile water a bit of the newly developed mycelium was placed on an agar plate in PETRI dishes.   At 20°-24° C. the fungus grows well on this agar medium within twenty four hours.   In order to avoid the development of contaminated bacterial colonies, repeated transplantations from the freshest part of the growing mycelium were necessary.   In many instances it was far better to set the plates in the position of inclination as suggested by EMOTO (9).   Soon after the pure culture of the fungus had been obtained, it was transplanted to a 0.05% haemoglobin solution as the stock culture.

The inocula of each experiment were always taken from 1% peptone agar transplanted from the stock culture within two days and grown at 20°-24° C.  A number of different media were used as a source of nutrition for the fungus and it was found to grow most vigorously in liquid media of a nutrient solution with peptone (peptone 10 g., potassium biphosphate 1.5 g., dist. water 1000 c.c.), potato decoction, pea decoction and " Milieu de GORODKOWA " (8).   Generally the fungus grew better and maintained vitality for a longer period in liquid media than on solid media, with the exception of steamed bodies of dead flies. But solid media such as a nutrient agar with peptone (a nutrient solution with peptone +1.7% agar), potato decoction agar, " Milieu de GORODKOWA " (8), " Milieu de SABOURAUD " (8), steamed potatoes and steamed peas were found to be suited to the fungus growth.   The 0.05% haemoglobin solution was favourable to the development of oospores, but not to the mycelial growth.

## The Relation of Temperature to the Growth
## of the Causal Fungus in Culture

The relation of temperature to the growth of the fungus was studied first by growing the mycelium on plates of poured nutrient agar with peptone, pea decoction agar and of " Milieu de GORODKOWA " incubated at different temperatures.  The same experiments were repeated three times.  The average of the results of these experiments is shown in Table I.  The figures in the table represent the diameter

of the fungus colonies developed within two days in centimeters. Since the fungus grows very rapidly, satisfactory results were obtained within two days.

TABLE I.  *Average of the diameters of the fungus colonies grown on agar plates at different temperatures*

| Temperature °C. | 6°–8° | 16° | 20° | 24° | 28° | 32° |
|---|---|---|---|---|---|---|
| Nutrient agar with peptone | 0.38 | 2.70 | 3.67 | 4.63 | **5.93** | 5.03 |
| Pea decoction agar | 0.37 | 2.93 | 4.03 | 5.67 | **6.23** | 5.40 |
| Milieu de GOROD- KOWA | 0.47 | 4.00 | 5.03 | 6.53 | **8.30** | 6.13 |
| Average | 0.40 | 3.21 | 4.24 | 5.61 | **6.82** | 5.52 |
| Order of growth | 6 | 5 | 4 | 2 | 1 | 3 |

The table shows that the fungus grows vigorously between 24°–32° C. and the optimum temperature seems to lie between 24° and 28° C. From this temperature downward growth decreased until it reached 6°–8° C., where very little growth took place.  At about 32° C. the fungus grew very vigorously and showed colonies almost identical in size with those developed at about 24° C.  In another series of experiments it was made clear that the growth of the fungus was checked considerably above 32° C. and no growth occurred at about 36° C.

SAWADA (**13**) pointed out that the mycelium of this fungus could not grow sufficiently at high temperatures and its sexual organs hardly developed at all, even though the mycelium grew.  The conclusion from the above described experiments differs, however, not only from SAWADA's opinion, but also from the well-known assumption that the disease is more abundant in northern countries or in years of cold weather.  During the experiment we noticed that in the case of such a rapid growing fungus the diameter of the colonies on the agar plate might sometimes not represent precisely the total amount of the mycelia grown.  Accordingly the relation of temperatures was then studied by growing the mycelium in liquid media of pea decoction, " Milieu de GORODKOWA " and of the nutrient solution with peptone incubated at different temperatures.  After being in culture for two weeks, the dry weights of the mycelium grown at each temperature

were compared. The average of the results of this series of experiments is shown in Table II. The figures in the table represent the dry weight of the mycelium in grams.

TABLE II.  *Average of the mycelial weight grown in liquid media at different temperatures*

| Temperature °C | 6°–10° | 16° | 20° | 24° | 28° | 32° |
|---|---|---|---|---|---|---|
| Pea decoction | 0.077 | 0.082 | **0.096** | 0.080 | 0.057 | 0.056 |
| Milieu de GOROD-KOWA | 0.085 | **0.151** | **0.150** | 0.110 | 0.093 | 0.082 |
| Nutrient solution with peptone | 0.083 | **0.094** | 0.088 | 0.080 | 0.078 | 0.074 |
| Average | 0.082 | 0.109 | **0.111** | 0.090 | 0.076 | 0.071 |
| Order of growth | 4 | 2 | 1 | 3 | 5 | 6 |

These data show that the greatest amount of growth takes place at 16° or 20° C. Differing from the results on agar plate the least growth occurred at about 32° C.

## Oxygen Requirements of the Causal Fungus

According to observation, SAWADA (13) stated that a sufficient supply of oxygen may be necessary for the growth of the causal fungus. Experiments were made, therefore, to obtain more accurate information on the relation of oxygen to the vegetative growth of the causal fungus. Agar slants were inoculated with the fungus, being plugged loosely with cotton. Each tube was kept in a more or less modified BUCHNER tube apparatus with alkalinated pyrogallic acid in order to exhaust the available supply of oxygen. The same experiments were repeated four times. In the control tubes treated in the same manner we used tap water instead of the pyrogallic acid. Besides the fungus in question *Hypochnus centrifugus, Hypochnus Sasakii, Pestalozzia Diospyri, Piricularia Oryzae, Helminthosporium Oryzae* and *Polystictus sanguineus* were compared under similar conditions. These experiments demonstrated that the fungus in question could grow moderately in the absence of oxygen, while all other fungi used did not ger-

minate at all.   According to calculation the amount of pyrogallic acid used was about ten times that sufficient to exhaust the oxygen in each apparatus.   This fact is very interesting and credible, because it may partially explain the ecological meaning in regard to the habitat of this fungus.   It still remains in question, however, as to whether the above results may not be owing to a change of pressure occuring in the apparatus, this being caused by exhaustion of the oxygen.   Therefore the effect on the growth of these fungi of a very limited and measured amount of oxygen was then studied.   Repeated experiments on the effect of partial pressure showed clearly that such a pressure reduced in proportion to the amount of the pyrogallic acid used did not measurably interfere with the mycelial growth or the spore germination of all the fungi used in this experiment.   Consequently the above conclusion on the effect of oxygen is perfectly reasonable.

## The Relation of Hydrogen-Ion Concentration to the Growth of the Causal Fungus in Culture

As to the effect of reactions of the medium on the growth of fungi belonging to the family Saprolegniaceae, little work has been done previously, so far as the writers know.   In 1909 LUTZ (12) reported that a 1% peptone solution changed to an alkaline reaction in consequence of the growth in it of a *Saprolegnia*.   According to SAWADA (13) the fungus in question grew most vigorously in a neutral solution and no growth occurred in a medium of acid reaction.   Since more detailed experimental studies on that problem are, however, very important, the junior author of this paper carried out an experiment repeated thrice. The medium employed was a 1% peptone solution, and its hydrogen-ion concentrations were adjusted by means of equal additions of hydrochloric acid or of caustic soda in various concentrations diluted from $\frac{N}{10}$ solutions.   The fungus in question was incubated at 24° C. in the ERLENMEYER flasks, each containing 50 c.c. of the medium with various hydrogen-ion concentrations between 2.8 and 8.2 in pH value.   The results of the experiment showed that the fungus was able to grow at a pH range between 4.0 and 8.2, and the best growth of the mycelium was obtained at the pH value, 6.2 to 7.2.   More alkaline media than pH 8.2 were not tested.   Another experiment showed also that owing to the growth of the fungus a 1% peptone solution showing pH 6.8 changed to pH 8.4 during a period of from fifteen to eighteen days.

## Inoculation Experiments of the Causal Fungus

In order to ascertain the parasitism of the fungus in question to rice seedlings, inoculation experiments were made by using various methods. The first method of inoculation was essentially the same as that used by STAKMAN (14) and also by many investigators in our laboratory as the sterile culture of the rice seedlings. Disease-free seedlings were required for this kind of inoculation. When sterile seedlings were prepared by the use of a special method, modified in our laboratory (10) from that described by HUTCHINSON and MILLER (11), they were planted in flasks of nutrient agar. At the same time we planted the fungus to be tested on the same medium. In these experiments, we used SACHS' solution containing 1% agar with or without 1% peptone. The degree of parasitism of the fungus was then judged by its effect on the development of the seedling, particular attention being given to the evidences of root and foot parasitism as judged in the smaller plants compared with the normal plants grown in controls. Examining these experiments further we found that 10 to 24% of the seedlings were apparently attacked by the fungus, while in controls no visible signs of the disease developed.

In the second series of experiments we planted the disinfected rice seeds on field soil in large glass cylinders. In each cylinder the soil to 3 cm. height was covered with sterilized water to 2 cm. depth. After the fungus in question was inoculated on each seed, the cylinders were placed on ordinary greenhouse benches for twenty eight days. During the experiment the temperature in the greenhouse ranged from 18° to 24° C. In the experiment only 8% of the plants were attacked by the fungus, but no disease occurred in the controls treated in the same manner. In the third series of experiments large PETRI dishes of 20 cm. in diameter were covered with a cotton cloth and 50 seeds, disinfected in our special sterilizer, were placed on each. The seeds were inoculated with the fungus grown in a pure culture. As controls 50 disinfected seeds were treated under the same conditions. By the aid of a rubber tube the water in the dishes was constantly renewed in order to avoid any bacterial development. The same experiment was repeated three times. Apparently owing to the introduction of the causal fungus by the aid of running water the disease occurred also in the controls. The diseased plants, however, occurred more abundantly in the inoculated series than in the control series. The experiment

showed conclusively that twenty percent of the inoculated seeds were infected by this artificial inoculation.

From the results of the experiments above stated the positive parasitism of *Achlya prolifera* to rice seedlings is distinctly recognizable. Its pathogenicity seems to be, however, not so destructive as is generally considered in our country.

## Toxic Action on the Rice Seedlings of the Medium Previously Staled by the Causal Fungus

In the first series of the inoculation experiments attention was called to the fact that the growth of many of the seedlings in the flasks of the inoculated series, seemingly not being penetrated by the hyphae of the causal fungus, was checked more or less, as compared with those grown in controls. Such a phenomenon may be caused by certain toxic substances produced in the medium by its chemical change or by the toxic excretions of the fungus.

In order to obtain information on the probable toxic properties of the staling substances given off by *Achlya prolifera*, some investigations were performed. As described in the previous chapter the fungus and the seedlings were grown on 100 c.c. of SACHS' nutrient solution with 1% peptone as well as 1% agar in 250 c.c. ERLENMEYER flasks at room temperatures in the greenhouse for 20-29 days. As controls the flasks in the same number were treated similarly, but not inoculated with the fungus (First Examination). After the fungus and the seedlings had all been removed, we sterilized them three days for one hour each day in a KOCH steam sterilizer. The seedlings only were grown again in the same manner as in the first examination for 14-15 days (Second Examination). The third examination was prepared similarly, after the seedlings of the second examination had been entirely cleared away. They were grown for 15-16 days. At the end of each experiment the length and the number of the leaves as well as the roots of seedlings were compared in detail. A similar experiment was repeated. The results of these two series of experiments are summarized in the following tables.

TABLE III.  *Results of Experiment A, relating to toxic action of*
*the medium staled by the fungus, on the rice seedlings*

| Examination | Average number obtained in the inoculated series | | | | Average number obtained in the control series | | | |
|---|---|---|---|---|---|---|---|---|
| | Leaves | | Roots | | Leaves | | Roots | |
| | Length | Number | Length | Number | Length | Number | Length | Number |
| 1st Examination | cm.<br>0.9 | 1.0 | cm.<br>trace | — | cm.<br>4.0 | 2.0 | cm.<br>2.8 | 5.2 |
| 2nd Examination | 4.2 | 2.8 | 0.3 | 6.9 | 12.3 | 3.7 | 4.7 | 8.5 |
| 3rd Examination | 5.5 | 3.0 | 1.0 | 7.6 | 10.8 | 3.1 | 5.2 | 6.7 |

TABLE IV.  *Results of Experiment B, relating to toxic action of*
*the medium staled by the fungus, on the rice seedlings*

| Examination | Average number obtained in the inoculated series | | | | Average number obtained in the control series | | | |
|---|---|---|---|---|---|---|---|---|
| | Leaves | | Roots | | Leaves | | Roots | |
| | Length | Number | Length | Number | Length | Number | Length | Number |
| 1st Examination | cm.<br>6.3 | 2.9 | cm.<br>1.2 | 5.8 | cm.<br>15.3 | 3.0 | cm.<br>6.6 | 10.6 |
| 2nd Examination | 5.9 | 3.8 | 2.2 | 4.1 | 14.0 | 4.0 | 6.8 | 6.4 |
| 3rd Examination | 7.1 | 3.8 | 2.7 | 5.4 | 10.6 | 3.8 | 3.2 | 5.9 |

Judging from the results indicated in Tables III and IV, we recognize that the poor development of the seedlings grown in the inoculated series, as compared with those in the control series, was not caused by insufficient nutrition.  Such a conclusion was proved by the fact that in the inoculated series the growth of the seedlings in the third examination was greater than that in the second examination, while in the control series the results were quite reversed.  Moreover the seedlings grown in the inoculated series showed always a diseased appearance in leaves and roots in spite of the absence of the causal fungus.  These facts indicate the presence of certain toxic substances in the medium, on which the fungus previously grew.

The change of pH value of the medium, owing to the fungus growth, was tested and has been already discussed in this paper.  It

changed from pH 6.4 to 8.4 in the alkaline direction. The writers therefore planted the rice seedlings on a medium of the same composition in ERLENMEYER flasks with its pH value controlled to 6.8 and 8.4. Half of the flasks of each pH value were inoculated with the fungus. The results of this experiment indicated that the probable change of pH value of the medium was not harmful to the rice seedlings. The seedlings grew better on the medium of pH 8.4 than on that of pH 6.6. This fact shows some toxic substance of an unknown character in the medium to be responsible for the poor development and the related pathological phenomena shown by the rice seedlings. This toxic substance is approximately thermostable.

# Summary

1.   In Japan a watermould very often attacks the seeds and the young seedlings of the rice plant grown under the water in nursery-beds. From Formosa to Hokkaido the rot disease is widely distributed causing serious damage.

2.   The causal organism of this disease must be referred to under the name of *Achlya prolifera* NEES.

3.   Pure cultures of the causal fungus were obtained by the plate-culture method using 1% peptone agar. Generally the fungus grew better and maintained vitality for a longer period in liquid media than on solid media, with the exception of the steamed bodies of dead flies. The 0.05% haemoglobin solution was favourable to the development of the oospores, but not to the mycelial growth. As the stock culture of this fungus the haemoglobin solution was used satisfactorily.

4.   The relation of temperature to the growth of the causal fungus was studied, using two different methods. We noticed that in the case of such a rapidly growing fungus as this causal organism, the diameter of the colonies developed on agar plate might sometimes not duly represent the total amount of the mycelium.

5.   The data represented by the dry weight of the mycelium grown in two weeks show that the greatest amount of growth of the causal fungus takes place at 16° or 20° C.

6.   The causal fungus is able to grow moderately in the absence of oxygen, while all other fungi used in our experiment do not germinate at all under the same conditions.

7.   The causal fungus was able to grow at a pH range between 4.0

and 8.2, and the best growth of the mycelium was obtained at the pH value, 6.2 to 7.2.   More alkaline media than pH 8.2 were not tested. Owing to the growth of the fungus, 1% peptone solution showing pH 6.8 changed to pH 8.4 during a period of from fifteen to eighteen days.

8.   The results of our experiments show that the positive parasitism of *Achlya prolifera* to rice seedlings is rightly recognizable.   Its pathogenicity seems to be, however, not so destructive as is generally considered in our country.

9.   The medium itself, in which the causal fungus grows vigorously, shows a tendency to check the growth of the seedlings of the rice plant.

This paper deals with an outline of the experiments already completed and the results may be discussed more in detail by the junior author in the future.   The expenses used in this investigation were partially defrayed out of an allowance from the Tôshôgû research fund.   The writers wish to express here their heartiest thanks to all the gentlemen who have kindly helped us in many ways.

March 10, 1928

<div align="right">

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### Explanation of Plate XVI

Fig. 1.  Rice-seedlings showing the result of an inoculation experiment.
      a.  Healthy seedlings as controls.
      b.  Inoculated seedlings.
Fig. 2.  Rice-seedlings showing the result of an experiment on the toxic action of the medium.
      a.  Healthy seedlings as controls.
      b.  Injured seedlings.

PLATE XVI



Fig. I

a
b

Fig. II

a
b

K. MATSUO phot.
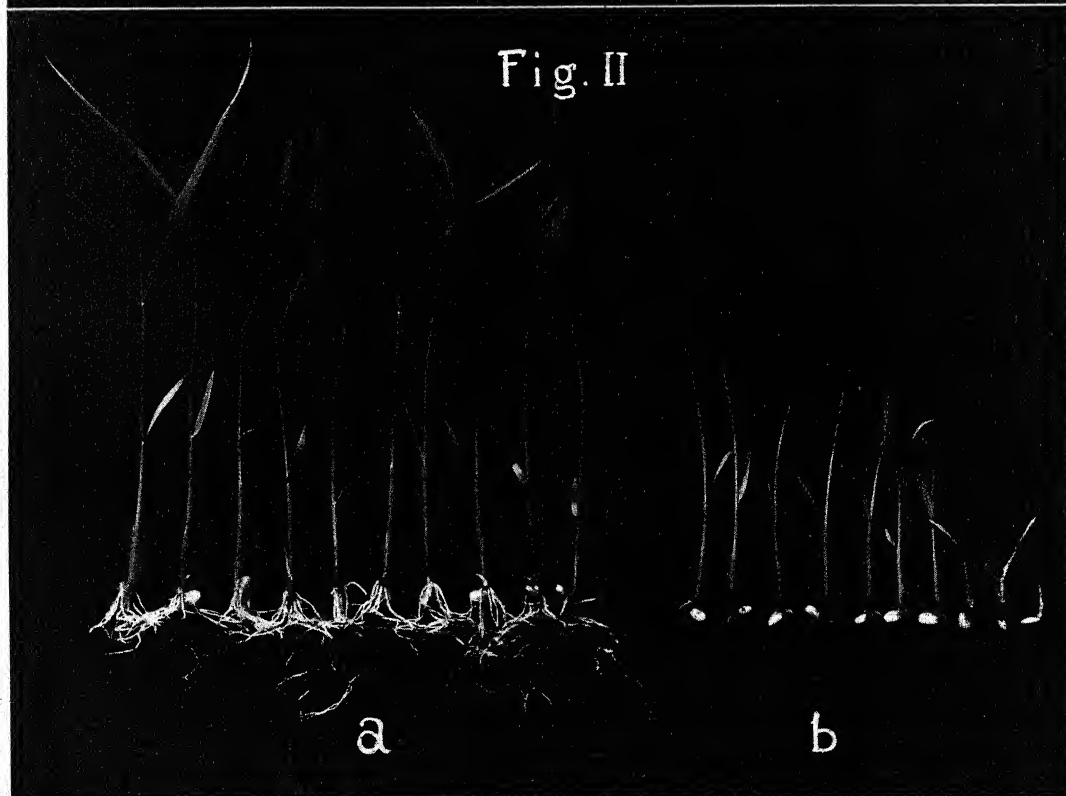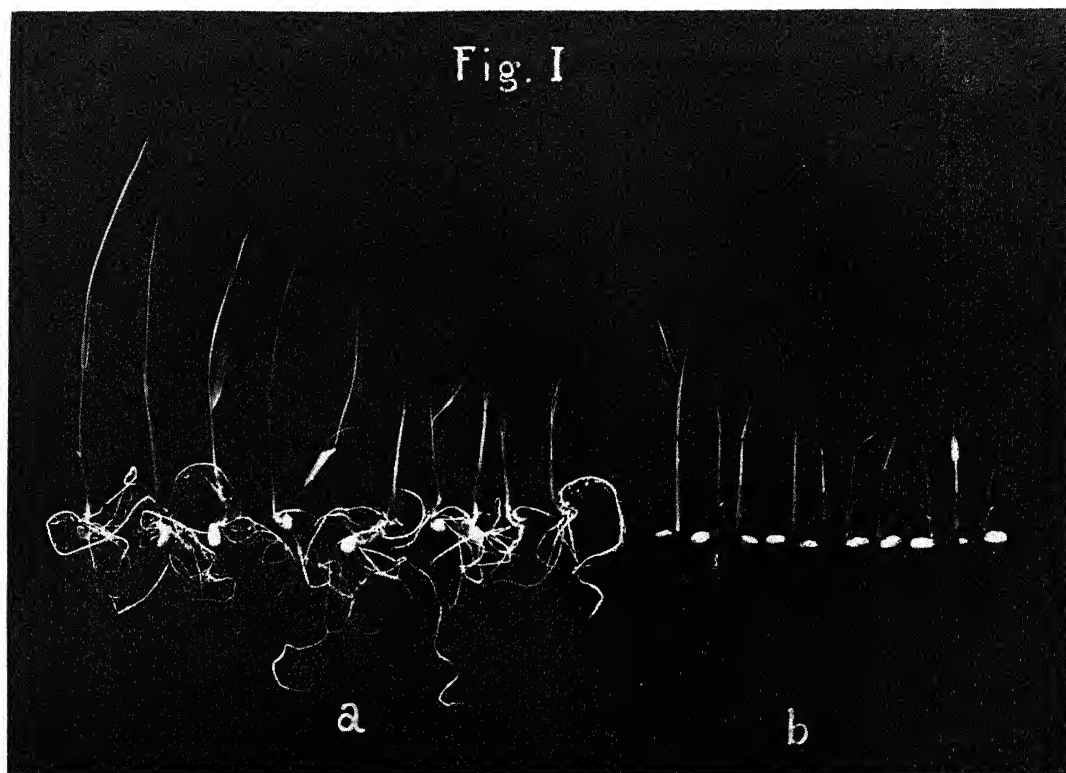
# On the Dioecism of Garden Asparagus
## (Asparagus officinalis L.)

By Takewo SHOJI and Toyobumi NAKAMURA

## Introduction

Several writers noted that the hermaphroditic individuals were occasionally found in garden asparagus which was generally conceived to be dioecious. NORTON (11) reported that in asparagus the hermaphroditic plants were always of male type, the flowers of which being for the greater part pure male and lacking the complete and functional ovary. HEXAMER (5) noted that in garden asparagus he observed, at least in one case, a plant which had been barren of seed at first changed into a seed-bearing plant the following year. ROBBINS and JONES (17) enumerated the following forms of flowers in asparagus: (1) strongly pistillate, (2) weakly pistillate, (3) hermaphrodite, (4) weakly staminate, (5) strongly staminate. They found only a very small percentage of true hermaphroditic flowers among the hundreds of flowers examined in Californian asparagus fields. One of the figures by them indicates a few berries set on a strongly staminate individual. It is not stated whether the hermaphroditic flower can be produced on pistillate individuals or not.

According to these observations, the sexual transition seems to occasionally occur in this crop. It is not clear, however, that the flower which produced the berry as mentioned by HEXAMER, etc. was female or hermaphroditic.

The floral polymorphism regarding sexuality was also cited in many other plants by different authors, such as ROSA (18) in Spinach, CORRENS (1) in *Silene Roemeri*, HIGGINS and HOLT (6) in *Carica Papaya*, and YAMPOLSKY (22) in *Mercurialis annua*, etc. The sexual polymorphism is conceived by some authors to be in relations with the hermaphroditism.

WILSON (21) wrote, "The rudimentary stamens and pistils in the different kinds of *Epigaea* flower showed that this had not always existed, but that the flower was once perfect." ROBBINS and JONES are of opinion that all the asparagus flowers are apparently potentially hermaphrodite, and during floral development, there occurs, except in rare cases, an abortion of one set of sex organs. That is, the abortion of one sexual organ in a potentially hermaphroditic flower plays one of the important roles in giving the opposite sex to this flower. CORRENS (1) stated, however, that the occurrence of hermaphroditic flower in *Silene Roemeri* was a result of the sudden development of pistils to be functional in the apparent staminate flower, but not owing to the development of stamens in the pistillate flower. The meaning of the sexual transformation to the plant itself was also discussed by several writers.

CORRENS (1) ascertained in *Silene Roemeri* that the hermaphroditic flower appearing on the staminate plant produced less seeds than the female flower in the pistillate plant, the seeds being lighter than normal seeds and having less germinating power, and the growth of the seedling from the seeds was very meager. CORRENS stated also that the hermaphroditic flower required more nutriments than the staminate flower (1) and, in poor nutrition, the hermaphroditic flower was produced less abundantly (2). NORTON (11) related that the berries produced on hermaphroditic plants were very small and rarely had more than one seed in them, and that the seed coats were usually not entirely developed. LEVITSKY (9) stated that hermaphroditic flowers in asparagus produced small and less-seeded berries. From these facts, it can be seen that the transformation from hermaphroditism to dioecism will be advantageous in the plant itself for the multiplication of descendants and the efficient utility of nutriment.

Furthermore, several statements were hitherto made on the factors by which the sexual transformations were brought about in different plants. CORRENS reported many cases in which the sexuality was predetermined by genetic constitution. ROSA (17) stated in his paper on spinach, that two types of male plants were produced due to genetic factors, and not to environmental influences. LEVITSKY (9) reported that the form and size of rudimental pistils were determined genetically and also in part influenced by outer conditions. KÔRIBA (7) is of the opinion that the degeneration, which results in the several grades of abortion of the sexual organ, can be brought about by two causes, namely, (1) by certain stimulant substance occuring in the

plant itself, and (2) by a spatial limitation for the development of the primordial organ. On the other hand, many authors proved that certain sexual transmutations were able to be controlled by environmental or nutritive conditions experimentally. For instance, MAE-KAWA (10) in *Arisaema japonica*, SCHAFFNER (19) in hemp, *Arisaema triphyllum* and *A. Dracontium*, etc., HIGGINS and HOLT (6) in *Carica Papaya*, and PRITCHARD (13) in hemp, etc.

In 171 individuals of garden asparagus examined by the writers, no hermaphroditic flower could be exactly determined. The abortion of pistils in staminate flowers and of stamens in pistillate flowers of garden asparagus is mainly discussed in this paper. The degree of the development of pistils in staminate plants and of stamens in pistillate plants is compared in different individuals, and the process of degeneration in the abortive sexual organs is traced histologically. The relation between the length of style and the degree of degeneration of ovule in male flowers as well as the receptivity of the stigma is also discussed. The difference of the period maturing to bloom in the staminate and pistillate individuals is pointed out.

This work was carried out in the Horticultural Institute, College of Agriculture, Kyoto Imperial University. The writers wish to express here their heartiest thanks to Prof. I. NAMIKAWA for his kind direction throughout the work. The writers are also much indebted to Prof. Y. TAKEZAKI for his valuable advices.

## Degree of the Development of Pistils in Staminate Flowers

Seeds supplied by a seedman under the varietal name of "Conover's Colossal" were sown in the spring of 1924. Some staminate individuals among the seedlings began to bloom in the autumn and they were transplanted in unglazed pots and adopted for the study. Soon after the collection of full-bloomed flowers from fifteen pot-plants in the summer of 1925, their perianths were cut off and sketches of their pistils were made in the following way. The pistils were put in a PETRI-dish with a sheet of section-paper stuck on its bottom and with 70% alcohol. Sketches were made in a certain magnitude under a dissecting-microscope.

The plants, Nos. 2, 3, 6, 7, 8, and 12, have weakly developed styles of about 1/5 mm. long (Fig. 1-b).

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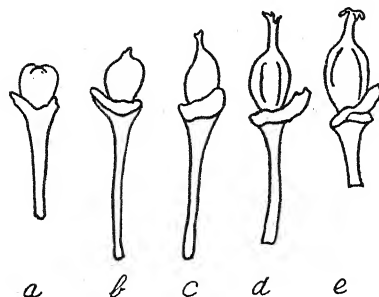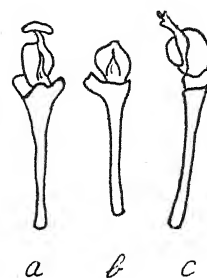


Fig. 1.　　　　　　　　　　　　Fig. 2.

Fig. 1.　*a*: Defective and styleless pistil in plant No. 15.　*b*: Defective pistil with weakly developed style in plant No. 8.　*c*: Defective pistil in plant No. 4.　The style is developed as long as half of that of the female plant.　*d*: Pistil in plant No. 11.　The style and stigma are almost equally developed as those of the female plant.　*e*: Functional pistil in the female plant No. 10.　Ca. 5/1.

Fig. 2.　*a*: An abnormal stamen transformed from a carpel in plant No. 13. *b*, *c*: Ovaries lacking a carpel in plants No. 1 and 11 respectively.　Ca. 5/1.

In the pistil of the plants Nos. 1, 9, and 15, the style was lacking and the ovary itself was also somewhat depressed (Fig. 1-a).　The style of the plants Nos. 4 and 5 was developed 3/5 mm. in length, equal to half of that of the female plants (Fig. 1-c).　In the plant No. 11, the styles and stigmas were almost equally developed as those in the female plants (Fig. 1-d.).　The pistil was developed very poorly in the plant No. 13, its size was very small, and one of the five ovaries examined had a stamen in the place of a carpel.　In this individual and in plant No. 11, one of the three carpels was not developed leaving a slit on some of the ovaries (Fig. 2-a, b).　For comparison, a normal pistil in the female plant No. 10 was presented in Fig. 1-e.

From these observations, it is obvious that in staminate individuals there are several transitional forms of pistils from entirely styleless to nearly full-developed specimens.　Though the development of pistils in male flowers varies very widely in different individuals, the degree of the development is nearly the same in each individual and no marked difference is found in the flowers from different parts of the same plant. It is remarkable that berries are produced in some male individuals. Though the flowers concerned in the berry production could not be examined, it may be probably conceived that some of the ovules in the stunted pistil might have undergone sudden change and become functional in such cases.

An ovary of the asparagus usually consists of three, sometimes two, and very rarely one or four carpels.
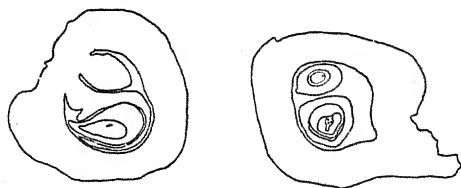


Fig. 3. Cross-sections through the one-carpelled ovary in the male plant No. 12. Ca. 30/1.
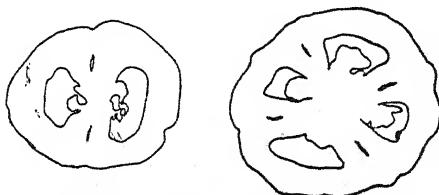


Fig. 4. Cross-section through the two-carpelled ovary in plant No. 12. showing no trace of the other carpel. Ca. 30/1.

Fig. 5. Cross-section through the four-carpelled ovary in plant No. 12. Ca 30/1.

One of the ovaries of the plant No. 12 (Fig. 3) is one-carpelled and contains two ovules. In the cross-section through the central part of it, it is not clear whether the two other carpels are lacking or aborted (Fig. 3-a), but the fact is clear in the lower part that it was originally three-carpelled and that two of them have aborted during their development (Fig. 3-b).

Two-carpelled pistils occur occasionally in male flowers and two types can be discriminated among them; the first, two-carpelled having from its beginning no traces of the other (Fig. 4), and the second, in which the third carpel stopped its development leaving its rudiment (Fig. 6). In the preparation stained with HEIDENHAIN's iron-haematoxylin, the epidermal layer of the abortive carpel is stained deeper than that of the other normal carpels. This feature indicates perhaps that considerable degeneration occurred in this part. One of the ovaries of the plant No. 12 (Fig. 5) is four-carpelled. This is really a very rare case.

In the plant No. 11, two cases are observed in which a stamen is produced taking the position of a carpel on the ovary and bearing an anther with apparently normal pollen grains in it. The anther is four-loculed in one case (Fig. 7) and two-loculed in another (Fig. 8).

HIGGINS and HOLT (6) found in *Carica Papaya* a case where a hermaphroditic flower bore an ovule on an anther. YAMPOLSKY (21) reported pistillody of the stamen and staminody of the pistil in *Mercurialis annua*. ROBBINS and JONES stated that there was no evidence of transmutation of pistil into stamen and of stamen into pistil in asparagus. The writers could not find a case of the pistillody of the stamen in asparagus. The staminody of perigones is also observed.
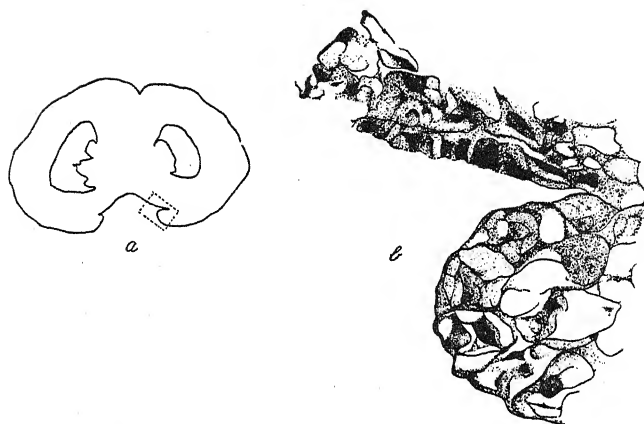
Fig. 6. *a*: Cross-section through the twe-carpelled ovary in the plant No. 11 showing a trace of the third carpel. Ca. 33/1. *b*: The epidermal layer of developed and abortive carpel is represented under further magnification. Ca. 400/1.
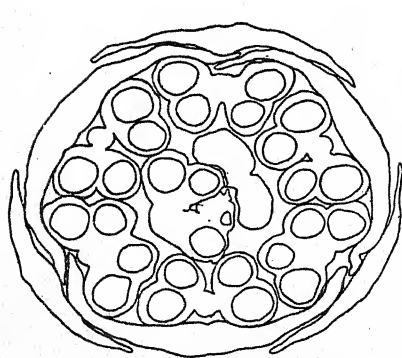


Fig. 7. Cross-section through a flower in the plant No. 11. One of the carpels is transmuted into a stamen with four-loculed anther. Ca. 30/1.
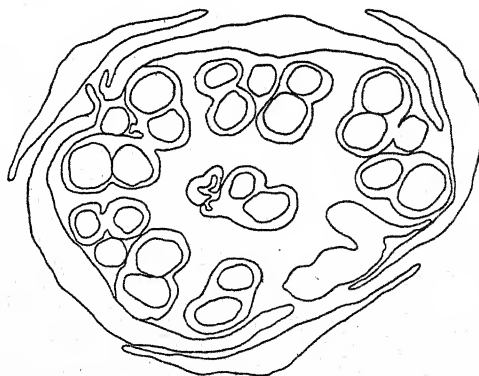
Fig. 8. Cross-section through a flower in the plant No. 11. One of the carpels is transmuted into a stamen with two-loculed anther. Ca. 30/1.
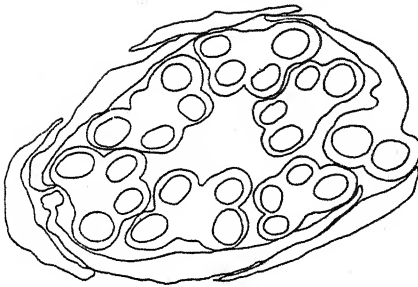
Fig. 9. Cross-section through a flower in the plant No. 14. Staminody is produced on one of the perigones. Ca. 30/1.
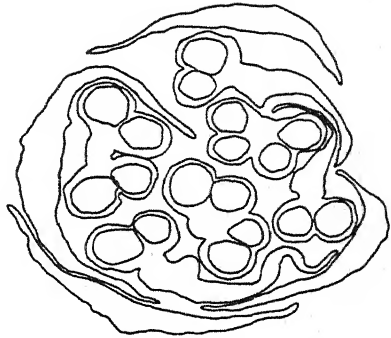
Fig. 10. Cross-section through a flower in the plant No. 13. Staminodies are produced on three of the perigones. Ca. 30/1.

In the plant No. 14, a flower has, besides six normal stamens, one abnormal stamen which is two-loculed and derived from one half perigone (Fig. 9). Three such abnormal anthers were observed in a flower of the plant No. 13 (Fig. 10).

## Determination of the Receptivity and Development of Stigma by Stigmatochromy.

ROBINSOHN (15) reported an interesting experiment on the staining reaction of stigma. He used two kinds of reagents for this purpose, an aqueous solution of potassium permanganate and an argentiferous mixture of the following dosis:

Sodium-potassium-tartarate ..............2.5g.
Silver-nitrate ..........................0.5g.
Rain water .........................1400.0g.

Treating stigmas of Umbelliferae, Compositae, and other flowering plants with these reagents, he found that the non-functional stigmas were not entirely or less stained than the functional. From this fact, he thought that the sterility of stigma seemed to be indicated by the staining reaction. As to the basis of stigmatochromy, he ascribed it to the physico-chemical properties of the surface structure of stigma where the pollen-tube may be able to germinate and penetrate it. As he said, the stigma is the point of junction in the whole life and in the biological relations of flowers. The stigma of a fertile pistil must be in favorable condition for the germination and penetration of the pollen-tubes. It

is said of the pollination of *Ginkgo* that a certain liquid is secreted from the nucellar tissue near the egg and the sperm swims in the liquid to the egg.    FUJII (4) stated that the pollination-liquid of gymnosperms is said to have strong reducing power.

If any particular substance or special conditions are detected by some reagents, it will be possible to determine the receptivity of pistils indirectly.    This test is based on an expectation that the receptive stigma may differ physico-chemically from a less receptive one. If, however, the same result can be obtained by stigmatochromy with a normal pistil of a female flower in a receptive stage and the other unreceptive pistils, the ovules of which are histologically determined functionless, the test is not appropriate for the determination of receptivity.    ROBINSOHN's stigmatochromy is very suggestive for the present work, and the same test was made with our material.

Materials :  Fifty flowers from male individuals were tested. Most of them were taken from pot-plants of which pistils had been histologically studied: five flowers from each of the individuals Nos. 1, 3, 4, 9, 13, and 15 ; eight flowers from No. 5 and two flowers from No. 8. As a comparison, five flowers from the plant F. 26 in the farm plot were used.

Twenty flowers from female plants were tested.    Ten out of them were taken from pot-plant No. 10 of which pistils had been histologically determined to be normal and were a little older than the other ten flowers, newly opened on a field plant F. 2.

Ten flowers from apparent hermaphrodite field plants were also tested, five of them being old and the others newly opened.

Method :   Perianths were plucked off with tweezers and the pistils were immersed for 30–40 minutes in ROBINSOHN's argentiferous solution.    The materials were then removed into a PETRI-dish with 70% alcohol, and sketches were made using a camera lucida.

Results of the stigmatochromy :  Stigmas in female flowers in receptive stage were satisfactorily stained as expected (Fig. 11).

But the stigma in the plant No. 10 (Fig. 12) in which the receptive stage was over and a slight wilting was seen, was stained scarcely or very weakly.    That is, the more receptive the condition of a stigma is, the
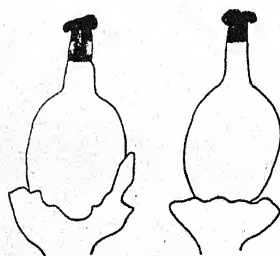


Fig. 11.   Well stained stigmas with stigmatochromy in young flowers of the female plant F. 2.  Ca. 10/1.

better can it be stained. In female flowers, at least, it seems that the receptivity and the staining strength are related, though the writers



missed a chance to examine the stigmas in the earlier stage before blooming. ROBIN-SOHN observed generally that the unripe stigmas were more difficult to stain than the full-developed ones. From these facts, the method seems to be useful for the determination of the receptivity of a stigma in relation to its stages of development.
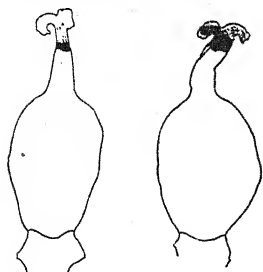
Fig. 12. Poorly stained stigmas in the plant No. 10. Ca. 10/1.

The results obtained in the old and young flowers in the plant F. 88 are in disagreement with the above case, but it may have been caused by a little difference between the stages of development of these two pistils (Fig. 13). Therefore it is over-hasty to conclude that the results are unreliable.
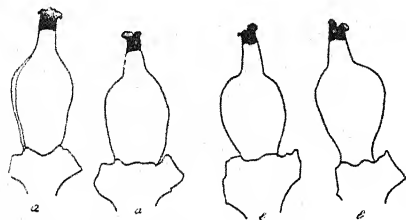


Fig. 13. Well stained stigmas in the apparent hermaphrodite plant. F. 88. Ca. 10/1. $a$: of young flowers. $b$: of old flowers.

In the plants, Nos. 1, 3, 7, 8, 9, 13, and 15, the stigma was lacking on the pistil. In these cases the staining was not detected even at the apex of the ovary. In two cases a small stained spot was seen at the upper part of the pistil. Careful examination shows that the spot appeared on a wound inflicted during the treatment.



Fig. 14. Pistils treated with stigmatochromy, $a$: in the plant No. 1, $b$: in the plant No. 7. Ca. 10/1.

It was quite unexpected that the stigmas were stained in the strongly staminate plants, Nos. 4, 5, and F. 26 (Fig. 15).

Thus the reliability of this method for the determination of the receptivity in the pistil becomes doubtful. If a stigma is developed even though imperfectly, it can be stained. We can not draw a line between the receptive stigma and the unreceptive one by this reaction. In the
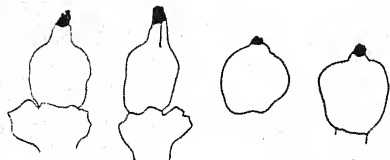


Fig. 15. The stained stigmas treated with stigmatochromy in the male plants No. 4. and F. 26. Ca. 10/1.

case of male flowers, consequently, the determination of receptivity by stigmatochromy is not reliable.

That the staining of the stigma occurs in a similar manner with that of a wound is, moreover, worth noting. A wound naturally has no cuticle on its surface. It would be supposed that the staining of a stigma also might be due to the lack of the cuticle. LEITMEIER-BEN-NESCH (8) ascertained actually in Liliaceae that the cuticle in the stigma was not detected in all the species examined by him except one. RITTINGSHAUS (14) enumerated two types in the behavior of pollen-tube growth as follows: (a) the stigma is imbedded in a certain muci-laginous substance and the pollen-tube performs its growth into the loose tissue without any disturbance, (b) the pollen-tube grows after it has absorbed the cuticle of the stigma. Some differences in the development of cuticle between the receptive and unreceptive stigmas may be possible. Some relations are also expected between the occurrence of cuticle on stigmas and stigmatochromy. ROBINSOHN also observed that the mangan-reaction on the whole cuticularized surface of the plant body was negative. The fact that there are no differences in the stigmatochromy between male and female flowers may suggest the lack of cuticle in the stigma of both male and female flowers.

Although the expected results could not be obtained, further studies of ROBINSOHN's stigmatochromy will be promising for investigation of the fertility and sterility in agricultural and horticultural lines.

## The Development of Ovules in Abortive or Sterile Pistils in Male Flowers.

ROBBINS and BORTHWICK (16) described the integuments of female flowers as follows: "At the time of the pollination, the inner integument of the ovule consists of two cell layers, and the outer integument of from five to ten layers. The line of demarcation between the integuments is sharpest near the micropyle. Here inner integument cells are more than they are posteriorly." The writers' observations with the integuments of the male as well as the female flowers agree generally with them.

Fig. 16 shows an ovule of a male flower in the earlier stage of degeneration. The inner integument is not developed so as to be sufficient to enclose the whole nucellus, and the outer integument scarcely attains half the length of the inner one. This fact agrees with the

LEVITSKY's result that the seed produced in hermaphroditic flowers has an opening on the seed coat which originated in the insufficient de-
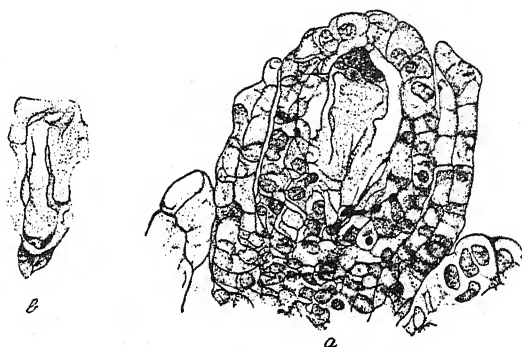


Fig. 16. *a*: An ovule of a male flower in earlier stage of the degeneration. *b*: next section to *a* in the serial preparation. Plt. No. 1. Ca. 400/1.

velopment of the integuments to enclose the nucellus. ROBBINS and JONES (17) also noted that the ovary of the staminate flowers of asparagus seldom developed further than the primary archesporial stage; the integuments seldom attained a size sufficient to enclose the ovule. They also related on the state of the pollen-grains at the earlier stage of the degeneration of the pistil in the same flower, that the anther had reached maturity. This agrees with the writers' result.

The figure of the ovule itself at the beginning of its degeneration is shown in Fig. 17. The meiosis of the megaspore-mother-cell has finished and the upper three cells show signs of degeneration. The outer integument has degenerated and other nucellar cells except four cells at the middle are very poor in protoplasm and their nuclei are less stained. Though it is not clear how early the degeneration occurs, it really occurs already at the time of the homotypic division of the megaspore-mother-cell.

In the case of the degeneration of the female gametophyte in 'Navel Orange', OSAWA observed often "that the megaspore-mother-cell shows the



Fig. 17. The ovule at the beginning of its degeneration. Plt. No. 1. Ca. 800/1.

signs of disintegration in synapsis or a little later.'' '' Generally, how-
ever, both in ' Unshu ' and 'Washington Navel Orange ' '', he noted,
'' the megaspore-mother-cell seems to pass through the heterotypic and
homotypic division, thus forming a row of four megaspores ; soon after,
when the upper three are degenerated to form deeply staining masses,
the fourth megaspore often becomes a very small feeble looking cell
with a small nucleus, which is scarcely distinguishable from the ad-
jacent nucellar cells.    Such megaspores
seem then soon to go into degeneration.''
In a similar manner, the degeneration  of
the pistil in male flowers in this plant begins
at a very early stage of development.

In Fig. 18 it is shown to what degree
the embryo-sac develops before degenera-
tion.   The embryo-sac is provided with an
egg, synergids, and antipodals.   However,
the integuments seem not always to reach
full development nor to enclose the nucellus
entirely even in this stage.   Especially, the
outer integument does not reach a half
length of the inner integuments.



Fig. 18.    An ovule with the
full    developed  embryo-sac
before the degeneration. Ca.
300/1.

Fig. 19 shows that the integuments degenerated so badly that the
original forms could not be easily traced.

According to FAMILLAR (3), the embryo-sac of Caprifoliaceae, Um-
belliferae, and Valerianaceae is generally well formed, but the integu-
ments are very weakly developed.   Tracing the process of the de-
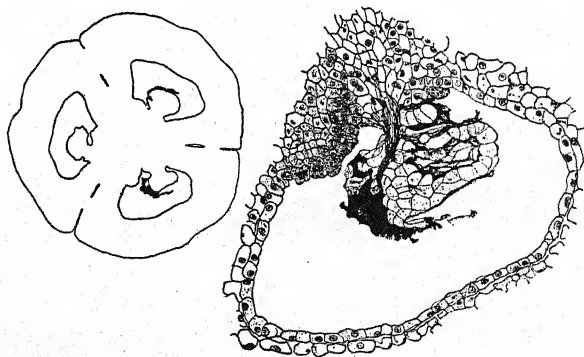


Fig. 19.   Badly degenerated ovule.   The original form of
the integuments could be hardly traced.   Ca. 175/1.

generation, it is assumed that the nucellus of asparagus fully develops once even in male flowers before the degeneration.
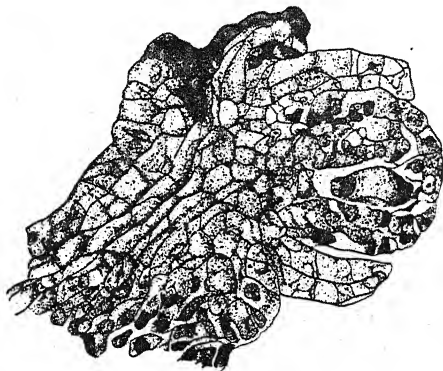


Fig. 20. An earlier sign of the degeneration of the ovule in the plant No. 1. Ca. 400/1.

As an earlier sign of degeneration, the cells at the base of the ovule lose the plasmic contents (Fig. 20) and become hard to be stained. Fig. 21 shows these weakly stained cells at the base of the ovules where they are attached to the placenta.
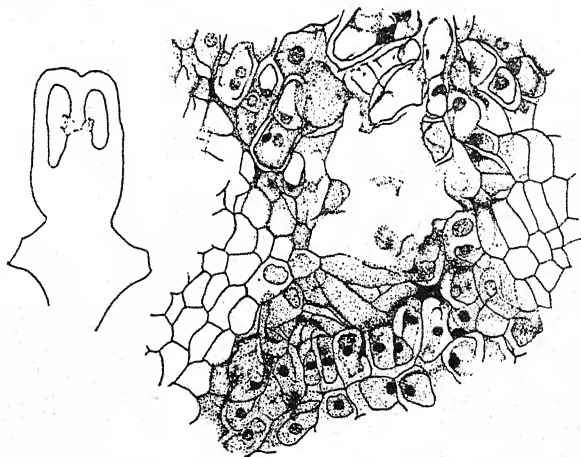


Fig. 21. Showing the stainless cells at the base of the ovule where they are attached to the placenta. Plt. No. 1. Ca. 400/1.

Degeneration of the outer integument follows and the disorganized cells become an intensively stained mass. In this stage, the inner integument remains still unstained (Fig. 22).

The inner integument remains considerably longer. After the outer integument has degenerated thoroughly, the inner layer out of two of the inner integument becomes degenerated. Fig. 23 shows this change. In this stage, the cytoplasm in the embryo-sac becomes very scarce.



Fig. 22. The disorganized and stained outer integument. Plt. No. 1. Ca. 400/1.
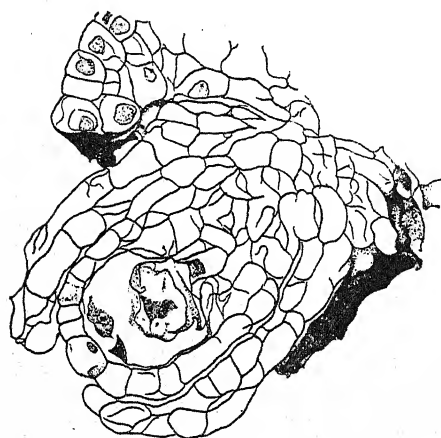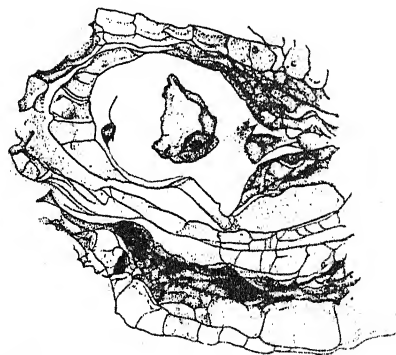
Fig. 23. The disorganized and stained inner cell-layer of the inner integument. Plt. No. 3. Ca. 400/1.

Then, the degeneration occurs in both micropylar and antipodal sides as shown in Fig. 24. The cytoplasm remains scarce in this stage though the nuclei in the embryo-sac are still visible. Then the nu-
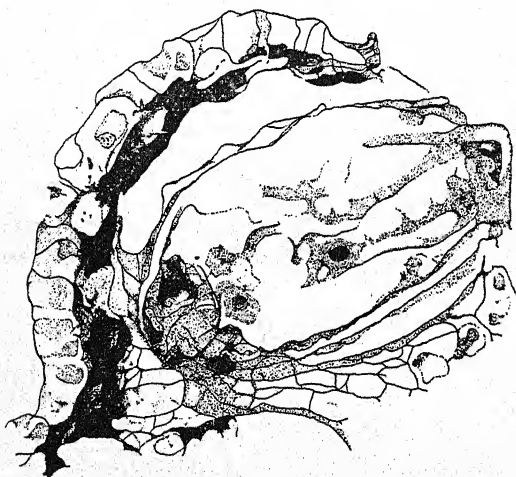


Fig. 24. The embryo-sac after the disorganization of the integuments. Plt. No. 3. Ca. 400/1.

Fig. 25.    Disorganized nucellar tissue; its plasma contents has entirely disappeared; a little later stage than Fig. 24.   Plt. No. 3.   Ca. 400/1.
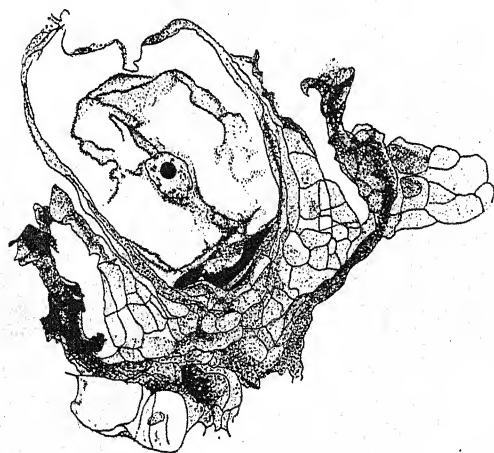


Fig. 26.   The secondary embryo-sac-nuclei (?) remaining to the last stage of the degeneration of the ovule.   Plt. No. 3.   Ca. 400/1.

cellar tissue loses its plasma content entirely showing its outline only.

After the integuments and nucellar tissue have degenerated thoroughly and their original positions become hard to be recognized, the egg apparatus remains still apparent, as shown in Fig. 24.

Of these nuclei in the embryo-sac, it could not be determined exactly which nucleus would survive to the last.    It is observed, however, that in many cases, only one normal nucleus, which is assumed to be the secondary embryo-sac-nucleus, occurs in the middle of the embryo-sac, while the others degenerate, as can be seen in Fig. 26.     Consequently, the secondary embryo-sac-nucleus seems to be the last to degenerate.   On the other hand, as shown in Fig. 25, two nuclei often occur in the middle of the embryo-sac.     These are two polar nuclei.    It is questionable whether the polar nuclei fuse before degeneration or not.

In conclusion, the degeneration in the ovule begins at first from the cells at the base of the ovule,

then it proceeds to the outer integument, inner integument, nucellar tissue, and finally to the embryo-sac.
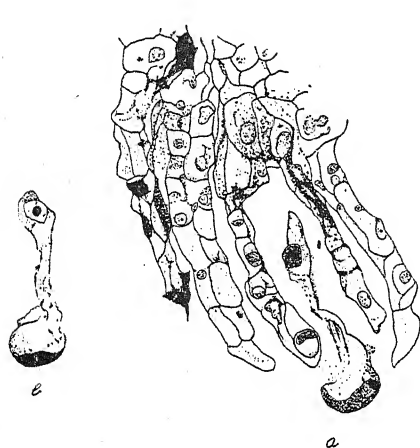


Fig. 27.  $a$: an embryo-sac pushed out of the nucellus.  $b$: next section to a in the serial preparation.   Plt. No. 3.  Ca. 400/1.
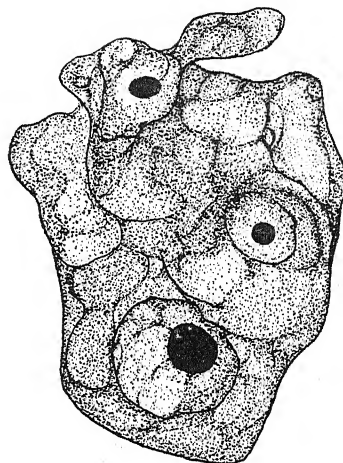
Fig 28.  A curious deformation of an embryo-sac. Plt. No. 1. Ca. 1730/1.

A curious feature of degeneration is presented in Fig. 27.  The embryo-sac seems to have been pushed out of the nucellar tissue and has become elongated and slender.  At a glance, it may be assumed
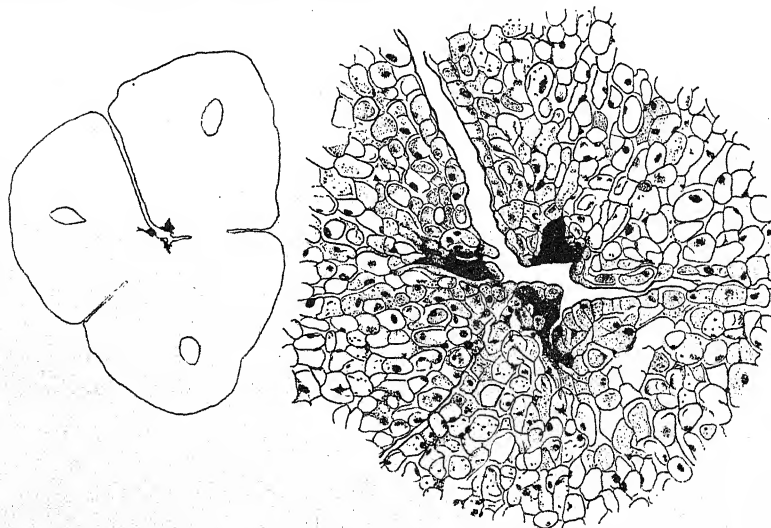


Fig. 29.   Showing the degeneration of the cells along the stylar canal in the male plant No. 1.   Ca. 230/1.

that this is due to being pushed in the course of preparation. But there is no sign of other destruction which may be considered to be due to outside force. The pushing out of the embryo-sac is likely to be a feature of the ovule-sterility.

Fig. 28 shows another case of the deformation of the embryo-sac, which contains three cells and is partially swelling out from the micropylar end.

Fig. 29 shows the cross-section of a style at the upper part near the stigma. Here, also, the degeneration is observed in the cells along the stylar canal. That is to say, the style in male flowers is not only stunted but also degenerates along the stylar canal.

## Relation between the Length of Style and the Degree of Degeneration of Ovule in Male Flowers.

Three types of male plants with (1) remarkably (2) moderately and (3) slightly stunted styles were selected and a comparison was made in the degree of degeneration of ovules in them.

Of course, the standard stage of development must be determined because the degree of degeneration of ovules is not the same in different stage of each flower. Asparagus is generally protandrous. Therefore, a comparatively earlier stage of pollen grains was chosen as the standard, for the reason that in the later stages of the pollen development, the degree of degeneration in pistils will be hard to be determined. The standard stage is shown in Fig. 30. In this stage, the pollen
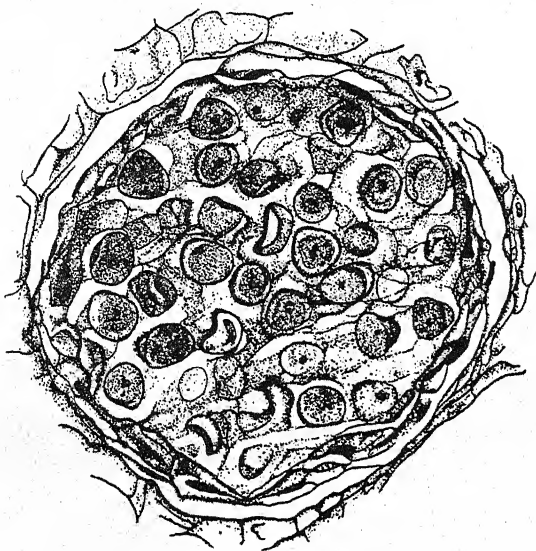


Fig. 30. The standard stage of pollen development applied in this study as an index of the degree of the development of flowers in different male individuals. Plt. No. 6. Ca. 350/1.

grains are suspended in an albuminous substance and surrounded with degenerating tapetal cells. Comparisons were made with the sections of an ovule cut in exactly transverse direction.

Fig. 31-a, -b, -c, show the development of pistils in the plants, Nos. 1, 6, and 11, which have remarkably, moderately, and slightly defected styles respectively. Pistils in the plants, Nos. 1 and 11, have
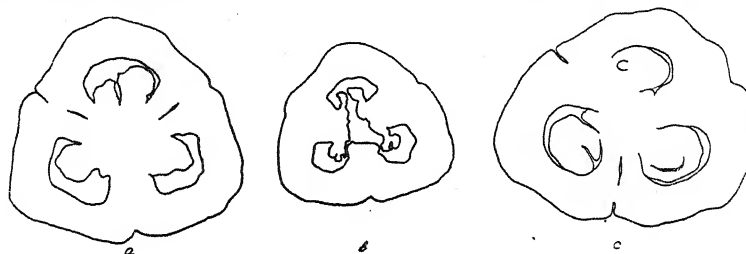


Fig. 31. Cross-section through the ovary showing the degree of the development of the ovule in the standard stage. *a* : of remarkably (Plt. No. 1.), *b* : of moderately (No. 6.), *c* : of slightly (No. 11.) defected pistil. Ca. 50/1.

no conspicuous differences in the degree of degeneration of ovules and in the size of ovaries. However, ovules in the plant No. 11 are developed comparatively better than in the plant No. 1. Pistils in the plant No. 6 are less developed than in the other two. The ovule degenerated more remarkably and the ovary is smaller than that in the plant No. 1. Thus, there was no parallelism between the stuntedness of styles and the degree of degeneration of pistils in the male flowers examined.

## The Development of Abortive or Sterile Stamens in Female Flowers
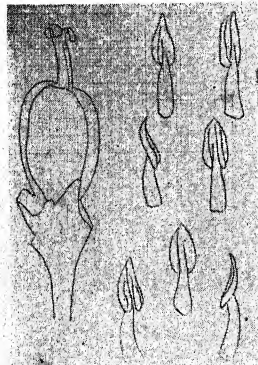


Fig. 32. The pistil and rudimentary stamens of the pistillate plant F. 12. Ca. 9/1.

The female flowers of the asparagus bear the rudimentary stamens as shown in Fig. 32. The development and degeneration of rudimentary stamens were studied in the female individuals. The materials were fixed with FLEMMING's fluid and stained with HEIDENHAIN's iron-alum haematoxylin.

The appearance of the archesporial cells, their differentiation into sporogenous cells and later into pollen-mother-cells, the formation of the fibrous cells, the tapetal cells and the middle layer, seem to be performed normally. This dif-

ferentiation is brought to perfection in all flowers collected from all
female individuals examined.   The degeneration takes place later.
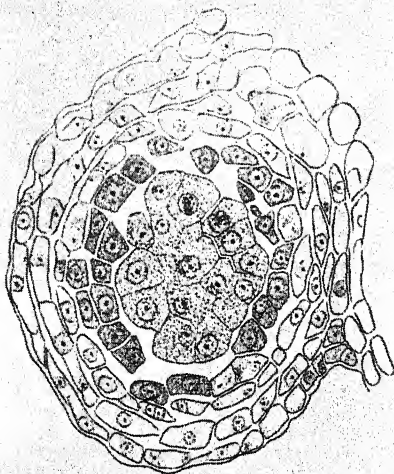


Fig. 33.   An anther locule of the
pistillate flower with pollen-mother-
cells in resting condition.   Ca. 430/1.
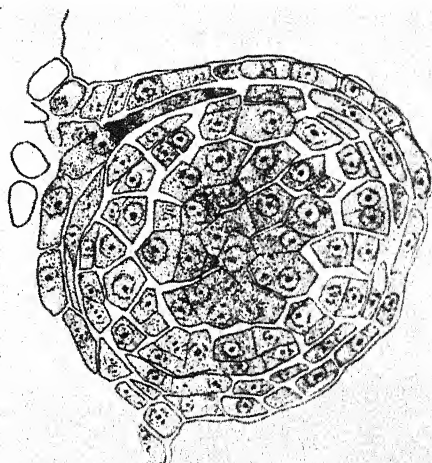


Fig. 34.   An anther locule of the
staminate flower with pollen-mother-
cells in resting condition.   Ca. 540/1.
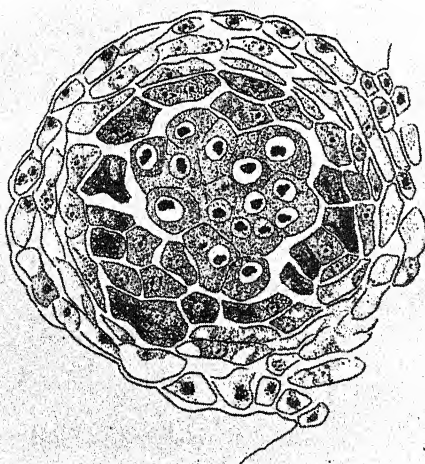


Fig. 35.   An anther locule of the pistillate
flower at synizesis.   Some of the tapetal cells
show sign of degeneration.   Ca. 490/1.

Fig. 33 shows an anther-
locule of the pistillate flower
with pollen-mother-cells in rest-
ing condition. Comparing with
that of the staminate flower
(Fig. 34), it seems that the
tapetum is merely more ir-
regular in shape and size. The
disorganization of the tapetal
cells begins usually at the sy-
nizesis of the pollen-mother-
cells (Fig. 35).

In a few cases, however,
the tapetal cells are found to
be disorganized when pollen-
mother-cells are still in resting
condition.   The degeneration
of tapetal cells can be detected at first by their intensive staining and
then by the disappearance of the nuclei.
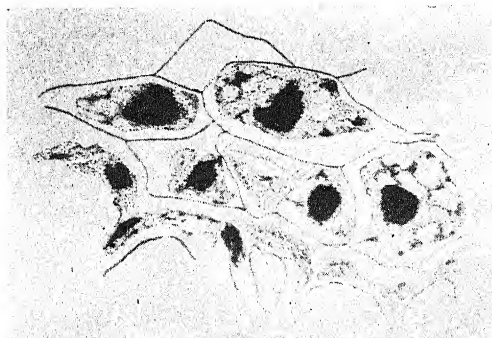
Fig. 36. Degenerating pollen-mother-cells before synizesis. Ca. 1240/1.

At the beginning of the degeneration of pollen-mother-cells, the deeply stained nuclei and granules are found in cytoplasm (Fig. 36). This is the sign of degeneration before the synizesis stage. In this stage, the cytoplasm shrinks and separates entirely from the cell wall. OSAWA (11) stated the same feature of degenerating pollen-mother-cells in *Citrus*. After the synizesis stage, in the male plants of asparagus, the pollen-mother-cells separate from each other, and become round. In the female, however, they do not separate and remain angular until the final disintegration (Fig. 45 and 46).
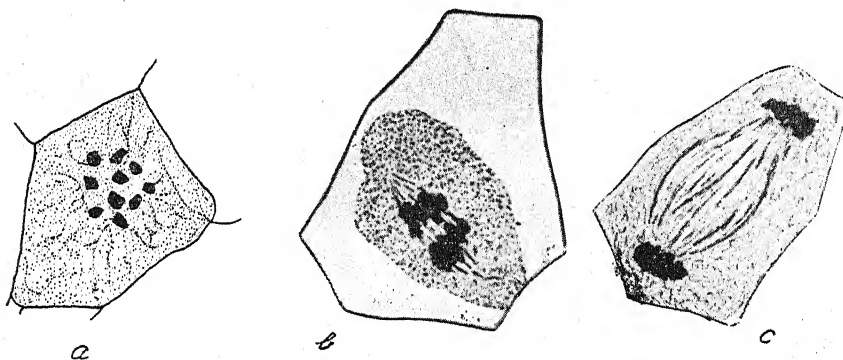


Fig. 37. Pollen-mother-cell in the female. *a*: at metaphase 1730/1 ; *b*: at anaphase, ca. 2140/1 ; *c*: at telophase, in the first division, ca. 1880/1.
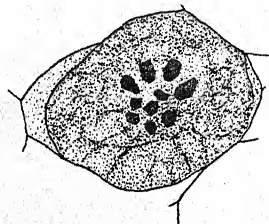


Fig. 38. Pollen-mother-cell at metaphase in the heterotypic division in a male flower. Ca. 1730/1.
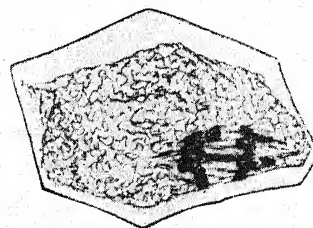


Fig. 39. Pollen-mother-cell at anaphase in the heterotypic division occurring at the biassed portion of the cell. Ca. 1910/1.

In most of the cases, the metaphase, anaphase, and telophase seem to be normal (Fig. 37). In metaphase, ten pairs of gemini are counted in the female as well as male plants (Fig. 37-a, and Fig. 38).

In all cases examined in female plants, the chromosomes arranged at the equatorial plate divide equally into the dyad cells. Occasionally, the normal heterotypic division does not take place at the middle portion in the cytoplasm but at the biassed portion (Fig. 39). In some cases, some chromosomes are found travelling toward the spindle poles ahead or behind the other ordinary chromosomes (Fig. 40). Some cases are observed, in which the membrane is produced in the equatorial plate of mitotic figure (Fig. 41). In this case, the cytoplasm does not shrink at all.

The homotypic division seems to be performed, but the liberation from the tetrad is not observed. The normal feature of the
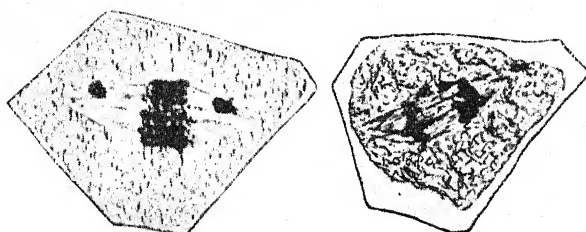
Fig. 40. Showing the chromosomes travelling toward the spindle poles ahead or behind the other ordinary chromosomes. Ca. 2000/1.
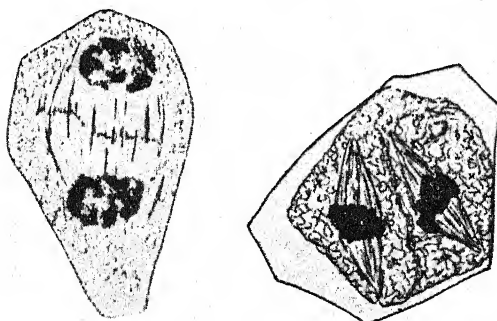
Fig. 41. Pollen-mother-cells at telophase with membrane appearing at the equatorial part. Ca. 2000/1.

Fig. 42. Pollen-mother-cell at metaphase of second mitosis. Ca. 2000/1.
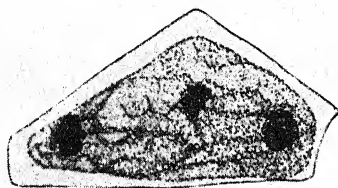
Fig. 43. Pollen-mother-cell at the abnormal telophase of second mitosis. Ca. 1980/1.
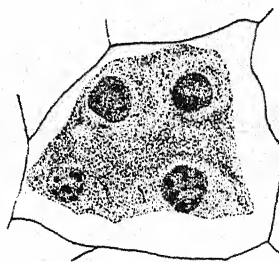
Fig. 44. Pollen-mother-cell after the meiosis is ended. Ca. 1730/1.

metaphase of homotypic division in the female is shown in Fig. 42.    In every case, the telophase of homotypic division shows more or less abnormalities.    Only three or four masses of daughter chromosomes in an original mother-cell are seen at telophase (Fig. 43).

After the meiosis is over, four nuclei which do not enter into the true resting stage are distinctly visible within the shrunken cytoplasm (Fig. 44).    The membrane formation between these four daughter cells is not distinct.
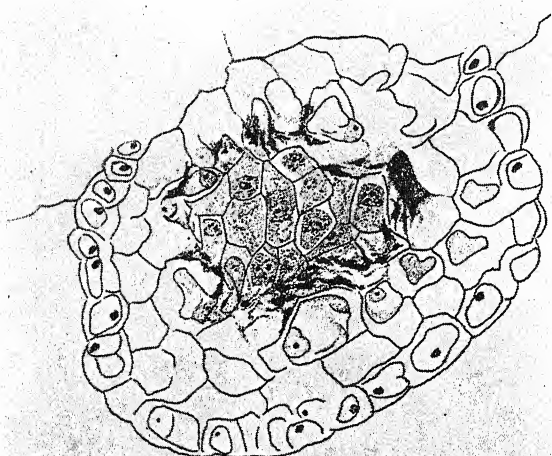


Fig. 45.    An anther locule of the pistillate flower with degenerating pollen-mother-cells and dispropotionally expanded middle layer of the anther wall. Ca. 460/1.
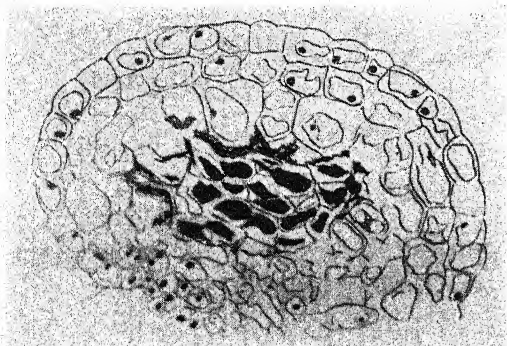


Fig. 46.    An anther locule of the pistillate flower, showing advanced disorganization of the pollen-mother-cells.  Ca. 340/1.

The earlier degeneration of tapetum has been observed in asparagus female flowers whenever the pollen - mother - cells show signs of degeneration.    From this fact, it may be conceived that the too early degeneration of tapetal cells is one of the factors which bring out the degeneration of pollen-mother-cells.

The anther locule becomes narrow by the disproportional expansion of the middle layer of the anther wall leaving the original cell walls of the disintegrated pollen-mother-cells (Fig. 46 and 47).    Finally, the anther becomes empty, semitransparent, and irregularly shrunken (Fig. 48).

In female flowers, the stages of develop-

ment of the pollen-mother-cells in different anthers vary more widely than in the male flowers, although almost the same in any one anther-locule. They vary also in different anther-loculi in any one anther as shown in Fig. 49, in which three of the loculi contain the disorganized pollen-mother-cells while the other one contains apparent normal pollen-mother-cells.
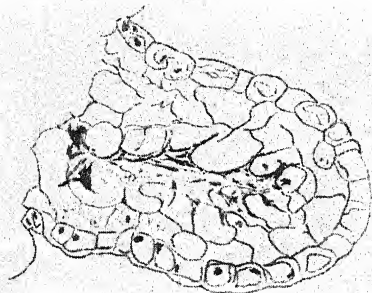
Fig. 47. An anther locule of the pistillate flower which has become narrow by the disintegration of its contents. Ca. 270/1.
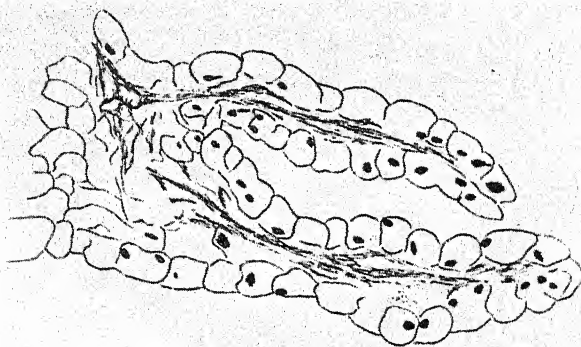


Fig. 48. Cross section through the stunted anther. Ca. 390/1.
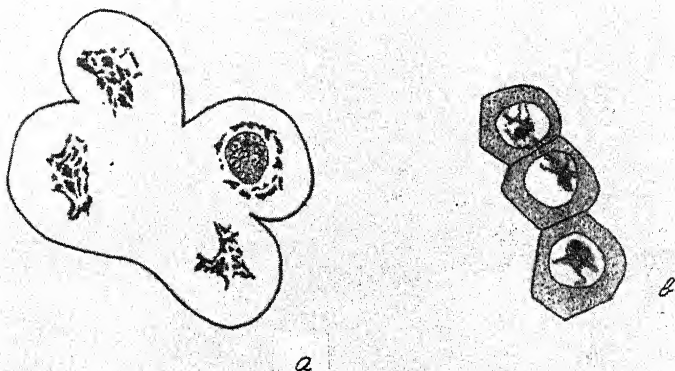


Fig. 49. Showing that the stages of development of the pollen-mother-cells vary in different anther-loculi in the same anther. a: Ca. 110/1. b: Ca. 840/1.

# The Difference of the Period Maturing to Bloom in the Staminate and Pistillate Individuals as One of the Secondary Sex Characters in Asparagus

Several authors reported on the secondary sex characters in dioecious plants; for instance, ROSA (18) in Spinach, YAMPOLSKY (22) in *Mercurialis annua*, etc.. ROBBINS and JONES (17) weighed the yield of spears in male and female asparagus, and stated that during the first harvest season from the transplanting of the crown, the average number and weight of spears from a crown was greater in male than in female and yet the difference of the yield was greatest during the early part of the season. It was observed that the staminate plants which reached sexual ripening later were very few and the shoots of these plants were less vigorous and bore only a few flowers. The growth of these individuals seemed to be checked by some conditions. We generally agree with ROBBINS and JONES who stated that in the life of the individuals the staminate plants of asparagus had a tendency to express their sex earlier than the pistillate. On this point, the following results were obtained in the present material.

*The time of sex expression in the seedlings of the preceeding year*

| Total Nos. of Individuals. | Number of plants in bloom or fruit. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Date \ Sex | May 8–14 | May 15–21 | May 22–28 | July 18 | Aug. 18–22 | Sept. 5 | Sept. 14–26 |
| 75 | Male | 36 | 16 | 3 | 4 | 2 | 4 | — |
| 81 | Female | 21 | 18 | 8 | 4 | 22 | — | 8 |

The number of pistillate plants counted after July were marked by the setting of berries. As the table shows, 73% of the staminate plants expressed their sex in May, while of the pistillate plants 58% only come to expression so early.

## Summary

(1) Asparagus is generally dioecious. Berries are produced rarely on some male individuals. It is not exactly determined, however,

whether the flower concerned in the setting of the berry was of hermaphroditic or female nature.

(2)   The staminate flowers have various pistils of several transitional forms from entirely styleless to apparently full developed ones.

(3)   The development of pistils in male flowers varies very widely in different plants.   But among the flowers of an individual plant the degree of development is nearly the same and no remarkable differences could be found in the flowers produced in different parts of the plant.

(4)   Each ovary of asparagus usually consists of three carpels. Sometimes two carpels, and very rarely one or four carpels constitute an ovary.

(5)   Staminodies of carpels and perigones are observed in some male individuals.

(6)   The degree of the development of stunted stamens in female flowers is almost the same in different individuals.

(7)   For the determination of receptivity, the method of stigmatochromy is not always reliable because the stigma shows a positive reaction even in male flowers.

(8)   The degeneration of the ovule in male flowers begins at the time of the homotypic division of megaspore-mother-cell.

(9)   The nucellus is developed fully once even in male flowers before degeneration.

(10)   The degeneration of ovules progresses in the following order: the cells at the base of the ovule, the outer integument, the inner integument, the nucellar tissue, and lastly the embryo-sac.

(11)   The style in male flowers is not only stunted, but also bears signs of disorganisation along the stylar canal.

(12)   There is no parallelism between the stuntedness of the style and the degree of degeneration in the ovules in male flowers.

(13)   In female flowers, the occurrence of the pollen-mother-cells, the tapetal cells, and the several layers of anther wall seem to be normal in the young anther.

(14)   The disorganization of the tapetal cells in female flowers begins usually at the synizesis stage of the pollen-mother-cells.

(15)   In most of the cases, the metaphase, anaphase, and telophase, seem to be normal in the heterotypic division.   And, at the metaphase, 10 pairs of gemini are counted in the female as well as male plants.

(16)   In female flowers, the following abnormalities are found in the development of pollen-mother-cells : (a) The cytoplasm of pollen-

mother-cells shrinks and separates entirely from the cell wall in the stage when the sign of degeneration begins to appear. (b) In some cases, some chromosomes travel toward the spindle poles ahead or behind the others. (c) Occasionally, the normal heterotypic division does not take place at the middle portion in the cytoplasm but at the biassed portion. (d) The homotypic division seems to be performed but the liberation from the tetrad is not observable. (e) The four daughter-nuclei do not enter into the true resting stage within the shrunken cytoplasm. (f) The membranes are not visible between four daughter cells.

(17) The degeneration of microsporangium in female flowers of asparagus begins with the revealing of deeply stained nuclei and granules in the pollen-mother-cells and finishes with the whole shrinkage of the microsporangium passing through the complete degeneration of the antecedents of pollen grains.

(18) In different anthers, the stages of development of pollen-mother-cells vary more widely in female flowers than in male flowers, although almost the same in any one anther-locule. They vary also in different anther-loculi in any one anther of female flowers.

(19) The anther-locule becomes narrow by the expansion of the middle layer of the anther wall. Finally, the anther become empty, transparent, and irregularly shrunken.

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# Three *Fusaria* Which Cause the Wilt Disease of Pea

By Kogo TOGASHI

## Introduction

In April of 1925, the seriousness of the losses due to the *Fusarium* infection of seedlings of the Alaska pea came to the writer's notice in the college farm of Kyoto Imperial University. After a careful study made on the characters, cultural and morphological, the causal organism was found to be attributable to *Fusarium arthrosporioides* SHERB. A month later in the same year, in the vicinity of Kyoto another form of *Fusarium* occurring on pea stem was collected by Mr. T. NOJIMA, an assistant in the Department of Agriculture of the University. This form was decided to be identical with *Fusarium sporotrichioides* SHERB. One more species of *Fusarium*, *F. anguioides* SHERB. was found by the writer at the same locality, causing the wilt disease of pea as in the case of *F. arthrosporioides*. The final decision on the identifications of these three *Fusaria*[1] was made with the help of Dr. H. W. WOLLENWEBER[2].

The present report contains the results of an intensive study on the cultural characters as well as the pathogenicity of these *Fusaria*, often with a comparison with that of *Fusarium martii* APP. et WR. var. *minus* SHERB.[3], two strains of which have been kindly furnished me by Drs. F.R. JONES, the author of the variety, and M.B. LINFORD, both of the University of Wisconsin. The work was done in part at the Phytopathological Laboratory of Kyoto Imperial University and the rest at my present laboratory in Morioka Imperial College of Agriculture and Forestry.

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(1) In our preliminary reports (1926, 1928), each species of *Fusarium* has been distinguished from the others under the provisional names of Form A, Form B and Form C.

(2) To whom the writer wishes to express his hearty appreciation for the kindness in deciding the species and also in reading this manuscript.

(3) Dr. WOLLENWEBER entertains an opinion that *Fusarium martii* var. *pisi* is but a synonym of *F. martii* APP. et WR. var. *minus* SHERB.

## Inoculation Experiments

To assertain the pathogenicity of *Fusarium arthrosporioides*, *F. sporotrichioides* and *F. anguioides* which were isolated from the affected stems of pea and to demonstrate the differences of infection power among these three organisms, eight inoculation experiments were performed under different conditions. In certain experiments *Fusarium martii* var. *minus* furnished by Dr. JONES was also used for comparison.

### PLAN AND METHOD

The inoculation experiments were divided into three sets containing experiments 1-8. The first set consisted of experiments 1-3, and it was undertaken to find whether each single spore strain of *F. arthrosporioides* will show the difference of infection power. The seed used in this set was Alaska variety. The second set was carried on to decide the comparative pathogenicity of our three *Fusaria* with single spore strains of each and also the resistant power of different varieties of pea against their attacks. For these experiments six varieties of pea were selected as following: Alaska, Pioneer, Sensation, Gladstone, Duke of Albany, The V.C. This set consists of experiments 4-5. As in the case of the second set, it was the purpose of the third set to determine the pathogenicity of our three species of *Fusarium* to Alaska variety and to compare the pathogenicity among our species and *F. martii* var. *minus* (JONES' strain). This set consists of the remaining three experiments.

A four-inch flower pot filled with a mixture of rich garden loam and sand was sterilized twice for one hour in KOCH's steam sterilizer with one day's interval (Experiments 1-5) or autoclaved for two hours at 130°C. under pressure (Experiments 6-8). Before sowing seeds, surface soil in the sterilized pot was thoroughly intermixed with the hyphal masses of pure culture. In the case of experiment 1, two cultures of test-tubes were used for each pot, in experiments 2-3, one for each pot and in the other cases two cultures of ERLENMEYER flasks (culture medium: steamed rice) for each three pots. The seeds of pea which were previously sterilized for five minutes in 0.1 per cent solution of mercuric chloride and rinsed in sterile distilled water were sown in each pot. In order to avoid the abnormality that seedlings grown in sterilized soil do not produce any of root tubercles, the seedlings were reared in the last two experiments under normal conditions, sterilized in

mercuric chloride solution and then replanted in the sterilized soil which had been intermixed with hyphae.

The first two sets of the experiments were carried on in the glass house of the Phytopathological Laboratory, Kyoto Imperial University and the rest, with the assistance of Mr. Eiji TSUKAMOTO, in the glass house of the Phytopathological Laboratory, Morioka Imperial College.

# Results

FIRST SET: When Alaska variety was inoculated with the strains of *Fusarium arthrosporioides*

TABLE I. *Showing the results obtained when two cultures of test-tubes were intermixed in the soil of each pot*[1]

| Species | *Fusarium arthrosporioides* | | | | | | | | | | | | | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strains | A—1 | | A—8 | | A—13 | | A—17 | | A—24 | | Control | | | |
| | α H M L | β | α H M L | β | α H M L | β | α H M L | β | α H M L | β | α | β | | |
| Exp. 1 | 7 13 0 | 0 | 8 12 0 | 0 | 5 12 0 | 3 | 16 4 0 | 0 | 8 12 0 | 0 | 0 | 50 | | Inoculated on May 19, 1925; observed on 16th day after inoculation |
| Total | 20 | 0 | 20 | 0 | 17 | 3 | 20 | 0 | 20 | 0 | 0 | 50 | | |
| % damage | 100 | | 100 | | 85 | | 100 | | 100 | | 0 | | | |

(1) In Tables I-V α denotes the number of damaged plants: H means heavy damage, whereby seeds do not germinate at all or plants die during the experiment, M moderate damage, whereby plants show the blackish girdled lesion, and L light damage with lesion not girdled.—β denotes the number of healthy plants.

TABLE II. *Showing the results obtained when one culture of test-tube was intermixed in the soil of each pot*

| Species | Fusarium arthrosporioides | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Strains | A—1 | | A—8 | | A—13 | | A—17 | | A—24 | | Control | | Remark |
| | α (H M L) | β | α (H M L) | β | α (H M L) | β | α (H M L) | o | α (H M L) | β | α | β | |
| Exp. 2 | 1 0 2 | 17 | 0 1 2 | 17 | 0 3 3 | 14 | 0 1 4 | 15 | 0 3 2 | 15 | 0 | 30 | Inoculated on June 15, 1925; observed on 22nd day after inoculation |
| Exp. 3 | 0 0 1 | 19 | 0 0 5 | 15 | 0 2 1 | 17 | 0 5 5 | 10 | 0 2 6 | 12 | 0 | 50 | Inoculated on June 27, 1925; observed on 13th day after inocul. |
| Total | 4 | 36 | 8 | 32 | 9 | 31 | 15 | 25 | 13 | 27 | 0 | 80 | |
| % of damage | 10.0 | | 20.0 | | 22.2 | | 37.5 | | 32.2 | | 0 | | |

A comparison of the data in Tables 1 and 2 indicates that the amount of the hyphal masses used as an inoculum gave a very considerable effect upon the percentage of damages though we had to inoculate with the same strains of the organism. To know this fact is most useful for plant pathological works.

Among the strains of *Fusarium* there was no conspicuously significant difference in their pathogenicity.

SECOND SET : When six varieties of pea were inoculated
with the strains of our three *Fusaria*

TABLE III. *Showing the results obtained when two cultures of*
ERLENMEYER *flasks were intermixed in the soil of each pot*

| Species | | F. *arthrosporioides* | | | | F. *sporotrichioides* | | | | F. *anguioides* | | | | Control | | | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strains | | A—8 | | | | B—30 | | | | C—33 | | | | | | | |
| Var. of pea | | α H M L | | | β | %d.[1] | α H M L | | | β | %d. | α H M L | | | β | %d. | α | β | %d. | |
| Exp. 4 | Alaska, Pioneer, Sensation, Gladstone, Duke of Albany, The V C | 0 0 0 | | | 20 | 0 | 0 0 0 | | | 20 | 0 | 0 0 0 | | | 20 | 0 | 0 | 20 | 0 | Inoculated on Sept. 29, 1925; observed on 17th day after inoculation |
| | | 2 9 9 | | | | 100 | 0 2 2 | | | 16 | 20 | 0 2 2 | | | 16 | 20 | 0 | 20 | 0 | |
| | | 5 11 2 | | | 0 | 90 | 3 1 1 | | | 15 | 25 | 0 0 4 | | | 16 | 20 | 0 | 20 | 0 | |
| | | 7 7 1 | | | 2 5 | 75 | 1 1 0 | | | 18 | 10 | 0 0 1 | | | 19 | 5 | 0 | 20 | 0 | |
| | | 3 5 8 | | | | 80 | 0 0 0 | | | 20 | 0 | 0 1 4 | | | 5 | 25 | 0 | 20 | 0 | |
| | | 6 7 1 | | | 4 6 | 70 | 4 2 1 | | | 13 | 35 | 0 2 5 | | | 3 | 35 | 0 | 20 | 0 | |
| Exp. 5 | Alaska, Pioneer, Sensation, Gladstone, Duke of Albany, The V C | 1 2 1 | | | 16 | 20 | 0 0 2 | | | 18 | 10 | 0 1 0 | | | 19 | 5 | 0 | 20 | 0 | Inoculated on Oct. 16, 1925; observed on 16th day after inoculation |
| | | 3 9 7 | | | 1 | 95 | 0 1 6 | | | 13 | 35 | 0 3 4 | | | 13 | 35 | 0 | 20 | 0 | |
| | | 4 8 8 | | | 0 | 100 | 0 0 1 | | | 19 | 5 | 0 0 1 | | | 19 | 5 | 0 | 20 | 0 | |
| | | 5 8 6 | | | 1 | 95 | 0 1 2 | | | 17 | 15 | 0 1 4 | | | 15 | 25 | 0 | 20 | 0 | |
| | | 3 6 8 | | | 3 | 85 | 0 1 2 | | | 17 | 15 | 0 2 6 | | | 12 | 40 | 0 | 20 | 0 | |
| | | 6 8 4 | | | 2 | 90 | 1 1 5 | | | 13 | 35 | 0 1 5 | | | 14 | 30 | 0 | 20 | 0 | |
| Total | | 45 80 55 / 180 | | | 60 | 75.0 | 9 10 22 / 41 | | | 199 | 17.0 | 0 13 36 / 49 | | | 191 | 20.4 | 0 | 240 | 0 | |

As shown in the above table, the three species of *Fusarium* were
all parasitic under the conditions of the experiments and *F. arthro-
sporioides* showed the most severe infection power making 75% of
damages in average, while *F. sporotrichioides* and *F. anguioides* were
rather weak with 17.0% and 20.4% of damages, respectively. The
same results were obtained in the next set which was examined on
Alaska peas. The Alaska variety showed far greater resistance against
the attack of *F. arthrosporioides* than other varieties of pea. In the
experiments of other sets, however, the variety was seriously damaged

(1) d.=damage

as we can see in Tables I, IV and V. It seems to us that this inconstancy may rather depend upon the fact that the seeds of Alaska used in this set had been newly harvested just before showing.

THIRD SET : When Alaska variety was inoculated with strains
of our three species. For a comparison, the JONES' strain
of *F. martii* var. *minus* was examined

TABLE IV. *Showing the results obtained when two cultures of*
ERLENMEYER *flasks were intermixed in the soil*
*of each three pots*

| Species | F. arthrospor. | | | F. sporo-trich. | | | F. anguioid. | | | F. mart. minus | | | Control | | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strains | A – 24 | | | B – 30 | | | C – 33 | | | JONES' | | | | | |
| | α H M L | | β | α H M L | | β | α H M L | | β | α H M L | | β | α | β | |
| Exp. 6 | 4 8 12 | | 6 | 0 0 2 | | 28 | 0 0 3 | | 27 | 3 22 5 | | 0 | 0 | 60 | Inoculated on Sept. 22, 1926; observed on 41st day after inoculation |
| Total | 24 | | 6 | 2 | | 28 | 3 | | 27 | 30 | | 0 | 0 | 60 | |
| % damage | 80.0 | | | 6.6 | | | 10.0 | | | 100.0 | | | 0 | | |

The results obtained in this set show conclusively that of the organisms tested *F. martii* var. *minus* caused the highest percentage of damages and then of our three species, *F. arthrosporioides* was the most serious parasite, *F. anguioides* the next, and *F. sporotrichioides*, the last. These data coincide with the results obtained in the second set. The interesting fact to note here is that the pathogenicity of our species appeared to be gradually enfeebled generation after generation. Strains of *F. arthrosporioides* which were extremely pathogenic in the previous year showing 45.3 (derived from Table I)-25.0 per cent (derived from Table III) of heavy damages to all numbers of the affected

plants only showed 6.0 per cent (derived from Tables IV-V) in this set. Such a fact that the members of *Fusarium* lost their virulence after growing in culture for a considerable length of time is proven by the recent works of BURKHOLDER (1925), WEIMER and HARTER (1926) and others. It is also an interesting fact that *F. martii* var. *minus* which had the highest degree in percentage of damages showed a much less percentage of heavy damages than *F. arthrosporioides*. A similar relation could be stated in comparing the heavy effects of *F. sporotrichioides* and *F. anguioides* to the plants (refer Table 3).

TABLE V.   *Showing the results obtained when the seedlings reared under normal conditions were used and two cultures of* ERLENMEYER *flasks were intermixed in the soil of each three pots*

| Species | *F. arthrospor.* | | *F. sporotrich.* | | *F. anguioid.* | | *F. mart. minus* | | Control | | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Strains | A—24 | | B—30 | | C—33 | | JONES' | | Control | | |
| | α H M L | β | α H M L | β | α H M L | β | α H M L | β | α | β | |
| Exp. 7 | 1 27 0 | 2 | 0 0 7 | 23 | 0 14 5 | 11 | 0 30 0 | 0 | 0 | 70 | Inoculated on Sept. 16, 1926; observed on 23rd day after inoculation |
| Exp. 8 | 0 30 0 | 0 | 1 0 8 | 21 | 0 2 6 | 22 | 0 30 0 | 0 | 0 | 80 | Inoculated on Oct. 10, 1926; observed on 30th day after inoculation |
| Total | 1 57 0 \ 58 | 2 | 0 15 16 | 44 | 0 16 11 \ 27 | 33 | 0 60 0 \ 60 | 0 | 0 | 150 | |
| % damage | 96.6 | | 26.6 | | 45.0 | | 100.0 | | 0 | | |

## Affected Plants

The initial evidence of the resulting lesion infected by *F. arthrosporioides* is a reddish brown streak on the portions of stem at the ground level. These streaks become elongated gradually down to just above the point of attachment of the cotyledons, coalescent and also they appear above ground, girdling the stem. The color of the lesion becomes dark brown to blackish brown. The sporodochia of light orange color are produced on the portions at the ground level or higher up. The affected plants suffering from lesion show a retarded growth, shrivel and sink, later becoming dry, their foliage more or less sickly yellowed ; incipient symptoms of wilting are becoming evident as soon as extensive vascular invasion has taken place (Pl. XVII and Pl. XVIII, Fig. 2). Usually the plants die very slowly, a majority of them living for a long period. The seeds most heavily damaged fail to germinate and rot under the ground being surrounded by the hyphae.

Such a symptom is also seen in the case of the other two species as well as of the JONES' strain with the following exceptions : 1. As stated by JONES (1923), and JONES and LINFORD (1925), *F. martii* var. *minus* attacks also rootlets, but new rootlets are produced in the lesion or above it (Pl. XVIII, Fig. 4), while in our cases with an exception of *F. anguioides* (Pl. XVIII, Fig. 3) these phenomena were not observed during the course of the experiments. 2. The sporodochia of *F. anguioides* are more or less grayish in color, when compared with those of others.

## Cultural Characters

A great deal of work has been done with pure cultures of our three species of *Fusarium*, and in certain cases the strains of JONES and LINFORD of *F. martii* var. *minus* were also used for comparison. The essential cultural characters shown by these *Fusaria* are collected in the accompanying tables.

### *Fusarium arthrosporioides*

Germination started within five hours at room temperature (about 25° C.) at both ends of the conidium or irregularly at its sides, and cylindrical arthrosporial microconidia were abundantly produced after about twenty hours (Pl. XIX, Figs. 7-9).

The fungus under consideration grew very vigorously on most cultural media, covering the whole surface with long cottony aerial mycelium. The aerial mycelium made often a definite zonation, white to vinaceous[1] in color and sometimes cream-colored on some media. Color production of this fungus was remarkably different according to the constituents of media as well as to the age of culture (Tables VI, VII, VIII, Pl. XX, Fig. 1 and Pl. XXI, Figs. 1, 6). For instance, on potato hard agar containing 2.5 per cent dextrose, the fungus showed a cameo pink to pomegranate purple color (Pl. XXI, Figs. 1, 6), while on the same medium, but containing 5 per cent dextrose, it showed more of a cream color to dresden brown and also on Koji hard agar a primuline yellow to yellow ochreous color.

The conidia produced on various cultural media were somewhat irregular in shape, more distinct in curvature, fewer in septation and longer in average length than that formed under natural conditions. In Tables IX, XIII, XVII, Plate XIX, Figs. 1, 3, 4, 5, 6, and Plate XIX, Fig. 2, the differences between them may be seen in detail.

It is generally accepted by the *Fusarium* worker (WOLLENWEBER, SHERBAKOFF, REIKING and others 1925) that repeated transfer of mycelium tends to good development of mycelium, but for production of abundant spores transfers should be made from sporodochia or pionnotes. This tendency was obviously recognized in this form of *Fusarium*. In plane culture it produced at first a considerable number of macroconidia in form of sporodochia, while in other cases, when transfers were repeated with bits of mycelium, sporulation was lacking except an only case of macro- and microconidial production in vinaceous buff mycelial sheets in the " Abkultur " of potato dextrose agar.

## *Fusarium sporotrichioides*

The fungus grew moderately on various media and aerial mycelium was scanty, showing vinaceous to cartridge buff in color. Zonation was marked on some media and often radiating growth occurred on the other media. Pseudopionnotes and sporodochia were very frequently formed and sometimes the so-called sporotrichial microconidia (Text-fig. 1, p. 185) were found in the conidial mass. In the mycelium intercalary chlamydospores (Pl. XIX, Fig. 13) were produced on certain media and took naples yellow or spinel red on raisin agar just as the hyphal

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(1) Designations of color are made according to RIDGWAY's " Color Standards and Nomenclature, 1912."

mass, while on potato agar with 2.5 per cent dextrose they were naples yellow or massicot yellow.

To judge from the data in Tables X, XIV, XVIII, and Figs. 10, 11, 12 in Plate XIX, it is evident that there are no significant differences between the conidia produced in cultural media and those formed under natural conditions when compared about their septation and shape. However, the average size of the former is somewhat shorter than that of the latter, while the data in width are just opposite.

The color production of this fungus will be seen in detail in Tables VII, VIII, Plate XX, Fig. 2 and Plate XXI, Figs. 2, 7.

## *Fusarium anguioides*

On the cultural study of this species of *Fusarium*, the most notable fact was that the conidia gave a remarkable difference in shape and size from that in nature. The conidia produced under natural conditions were narrowly elongated in shape with slightly attenuated ends, curved, apedicellate, rarely slightly pedicellate, typically 5-septate and $71.00 \pm 0.56$ by $3.02 \pm 0.01 \mu$ in mean, while the conidia in culture were far shorter in length, broader in the middle parts, mostly more distinctly pedicellate and fewer in septation (Pl. XIX, Figs. 15, 16, and Tables XI, XV) than that formed under natural conditions (Pl. XIX, Fig. 14, and Table 19).

The other cultural characters will be seen in Tables VII-VIII, Plate XX, Fig. 3, and Plate XXI, Figs. 3, 8.

## JONES' and LINFORD's strains of *Fusarium martii* var, *minus*

In his information dated November 26, 1927, Dr. WOLLENWEBER says, " The LINFORD's strain agrees in every detail with *F. martii* APP. et WR. var. minus SHERB. Furthermore I am pretty sure that the latter is identical with *F. martii* var. *viride* SHERB., since the variation in spore measurements and color shades in *F. martii* var. *minus* would cover the slight differences here observed. More and more we made the experience, that we can get sectorial variants from single spore petri-dish cultures of a given fungus with color shades differing constantly from the original strain. BROWN and HORNE have shown this to be a fact in their *F. Blackmani*, which is identical with *F. fructigenum* FRIES of section Lateritium."

The LINFORD's strain showed higher sporulation and deeper coloring in substrata than the JONES' strain which is older than the former.

These characters may be obviously seen when one compare the data in Table VIII, Plate XXI, Figs. 4, 9, and Plate XXI, Figs. 5-10.

Although the results of our cultural experiments corresponded in many respects with the JONES' description (1923), slight differences in color development, in size of conidia, and sometimes in percentage of conseptated conidia might occur. These slight differences may be easily neglected, if we take into account the well known variability of *Fusaria* (APPEL and WOLLENWEBER 1910, WOLLENWEBER 1914, SHERBAKOFF 1915, WOLLENWEBER, SHERBAKOFF, REINKING and others 1925, BROWN 1925, BROWN and HORNE 1926). According to our measurements the conidia of *Fusarium martii* var. *minus* (LINFORD's strain) were somewhat shorter in length, averaging 8-36 $\mu$, 22.91 ± 0.10 $\mu$ and fewer in sepattion having the highest percentage of 3-septation. JONES (1923) says "The predominant green or blue color of the larger part of the spore mass is a conspicuous character, at least in older cultures." However, in certain cases such as on agar media of kidney bean, barley seedling, and raisin, the color of pseudopionnotes were pinkish (flesh pink) to yellowish (pale orange yellow), yellowish (yellow ocher), and vinaceous (vinaceous fawn), respectively, even in high culture.

TABLE VI.  *Essential cultural characters of Fusarium arthrosporioides on different agar plates.   Culture 21 days old at room temperature of 15–23° C.*

| Agar used | Growth | Aerial mycelium | Zonation | Sporulation | Color | |
|---|---|---|---|---|---|---|
| | | | | | From above | From beneath |
| Potato with 2% dextrose | Very vigorous | Very abundant | Definite | Scarce | White, cameo pink | Cameo pink, pomegranate purple; center burnt lake |
| Corn meal | Vigorous | Few | None | Moderate | White | Eugenia red |
| Banana | do | Moderate | Very slight | do | Ochraceous-salmon, salmon orange; center pomegranate purple | Pomegranate purple |
| Apricot | do | do | None | do | White | do |
| Koji | Very vigorous | Abundant | Slight | Scarce | White, mustard yellow, center raw sienna | Primuline yellow, yellow ocher |

TABLE VII. *Essential cultural characters of our three species of Fusarium grown on different agar plates. Culture 38 days old at room temperature of 28–33° C.*

| Agar used | Species | *F. arthrosp.* | *F. sporotr.* | *F. anguioid.* |
|---|---|---|---|---|
|  | Strains | A—24 | B—30 | C—33 |
| Potato | Growth | Moderate | Moderate | Vigorous |
|  | Zonation | Definite | Definite | Slight |
|  | Sporulation | None | None | None |
|  | from above | White | White | White |
|  | Color from beneath | Cream color | Cream color | Cream color |
| Potato with 5 % dextrose | Growth | Very vigorous | Vigorous | Very vigorous |
|  | Zonation | None | None | None |
|  | Sporulation | None | None | None |
|  | from above | White; cream color | White; center vinaceous | White |
|  | Color from beneath | Cream color, dresden brown | Cream color, bordeaux; center pomegranate purple, vinaceous | Honey yellow, isabella color |
| Potato with 5% glucose | Growth | Vigorous | Vigorous | Vigorous |
|  | Zonation | None | None | None |
|  | Sporulation | None | None | None |
|  | from above | White; cream color | White; center vinaceous | White |
|  | Color from beneath | Cream color, dresden brown | Cream color, pomegranate purple, bordeaux | Honey yellow isabella color |

## TABLE VII  (*Continued*)

| Agar used | Species | F. arthrosp. | F. sporotr. | F. anguioid. |
|---|---|---|---|---|
|  | Strains | A—24 | B—30 | C—33 |
| Banana | Growth | Vigorous | Vigorous | Very vigorous |
|  | Zonation | Slight | Slight | Slight |
|  | Sporulation | None | None | None |
|  | from above | White | White; 1st Zone vinaceous | White |
|  | Color from beneath | Isabella color; center honey yellow | 1st zone pomegranate purple, bordeaux | Isabella color; center honey yellow |
| Pea | Growth | Moderate | Moderate | Vigorous |
|  | Zonation | Slight | None; radiate growth | None |
|  | Sporulation | None | None | None |
|  | from above | White | White | White |
|  | Color from beneath | Cream color | Cream color | Cream color |
| Sliced potato | Growth | Very vigorous | Very vigorous | Very vigorous |
|  | Zonation | None | None | None |
|  | Sporulation | None | None | None |
|  | Color from above | White, vinaceous | Vinaceous, cartridge buff | White, pinkish buff, pallid mouse gray |

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TABLE VIII. *Essential cultural characters of our three species and Fusarium martii var. minus grown on different agar slants. In an incubator of* 30° C.

| Agar used | Species | F. arthr. | F. sporotr. | F. anguioid. | F. mart. pisi | | Remark |
|---|---|---|---|---|---|---|---|
| | Strains | A—24 | B—30 | C—33 | Jones | Linford | |
| Potato | Growth | Vigorous | Moderate | Moderate | Moderate | Moderate | On 17th day after inoculation |
| | Aerial mycelium | Abundant | Few | Moderate | Absent | Absent | |
| | Sporulation | None | Moderate (Salmon color, salmon buff)[1] | None | Moderate (Deep glaucous green, light porcelian green) | Abundant (Deep greenish glaucous) | |
| | Chlamydospores | None | None | None | Few | Few | |
| | Color of media | Pinkish-buff | Pinkish buff, cinnamon-buff | Pinkish-buff | Pinkish-buff, vinaceous fawn | Pinkish-buff, cinnamon-buff | |
| Potato with 2.5% dextrose | Growth | Vigorous | Moderate | Moderate | Moderate | Moderate | On 13th day after inoculation |
| | Aerial mycelium | Very abundant | Abundant | Moderate | Few | Few | |
| | Sporulation | Few[2] | Scarce | Few | None | Abundant (Deep bluish gray-green) | |
| | Chlamydospore | None | None | Few | None | Moderate | |
| | Color of media | Yellowish glaucous | Naples yellow, massicot yellow | Ochraceous-buff | Reed yellow, pale pinkish buff | Light pinkish cinnamon | |
| Oat | Growth | Slight | Slight | Slight | Slight | Slight | On 12th day after inoculation |
| | Aerial mycelium | Few | Few | Few | Few | Few | |
| | Sporulation | None | None | None | None | Few | |
| | Chlamydospore | None | None | None | None | None | |
| | Color of media | Faint | Faint | Faint | Faint | Faint | |

(1) The designation in parentheses show the color of pseudopionnotes or pionnotes.

(2) Macro- and microconidia were produced in the "Abkultur."

TABLE VIII  (*Continued*)

| Agar used | Species | F. arthr. | F. sporotr. | F. anguioid. | F. mart. pisi | | Remark |
|---|---|---|---|---|---|---|---|
| | Strains | A—24 | B—30 | C—33 | Jones | Linford | |
| Soy bean | Growth | Vigorous | Moderate | Moderate | Slight | Moderate | On 16th day after inoculation |
| | Aerial mycelium | Very abundant | Moderate | Abundant | None | Moderate | |
| | Sporulation | None | Abundant (La France-pink) | None | None | Moderate (Deep greenish glaucous) | |
| | Chlamydospore | None | None | None | None | None | |
| | Color of media | Ochraceous tawny | Ochraceous tawny | Verna brown | Ochraceous tawny | Ochraceous tawny | |
| Soy bean with 2% dextrose | Growth | Vigorous | Moderate | Vigorous | Moderate | Moderate | On 12th day after inoculation |
| | Aerial mycelium | Very abundant | Moderate | Very abundant | Moderate | Few | |
| | Sporulation | None | None | None | None | Moderate (Light mineral gray) | |
| | Chlamydospore | None | None | None | Few | Few | |
| | Color of media | Light brownish vinaceous | Faint | Light brownish vinaceous | Light brownish vinaceous | Carnelian red | |
| Kidney bean | Growth | Vigorous | Moderate | Moderate | Moderate | Moderate | On 13th day after inoculation |
| | Aerial mycelium | Very abundant | Few | Few | Few | Few | |
| | Sporulation | None | Moderate (Grenadin pink) | Moderate (light salmon orange) | Moderate (Pale orange-yellow) | Abundant (Flesh-pink, pale orange yellow) | |
| | Chlamydospore | None | None | None | None | None | |
| | Color of media | Hay's russet | Hay's russet, liver brown | Hay's russet, liver brown | Hay's russet, liver brown | Hay's russet, liver brown | |

TABLE VIII  (*Continued*)

| Agar used | Species | *F. arthr.* | *F. sporotr.* | *F. anguioid.* | *F. mart. pisi* | | Remark |
|---|---|---|---|---|---|---|---|
| | Strains | A—24 | B—30 | C—33 | Jones | Linford | |
| Barley seedling | Growth | Moderate | Moderate | Moderate | Moderate | Moderate | On 26th day after inoculation |
| | Aerial mycelium | Few | Few | Few | Moderate | Few | |
| | Sporulation | None | Moderate (Orange-cinnamon) | None | None | Moderate (Yellow ocher | |
| | Chlamydo-spore | None | None | None | None | None | |
| | Color of media | Faint | Faint | Faint | Faint | Faint | |
| Raisin | Growth | Vigorous | Moderate | Vigorous | Moderate | Moderate | On 16th day after inoculation |
| | Aerial mycelium | Abundant | Few | Abundant | Few | Few | |
| | Sporulation | None | Few (Naples yellow, spinel red) | None | None | Abundant (Vinaceous-fawn) | |
| | Chlamydo-spore | None | Moderate | None | None | Abundant | |
| | Color of media | Cinnamon-buff | Spinel red, diamine brown | Eugenia red | Orange vinaceous, | Orange vinaceous, vinaceous fawn | |
| Pea | Growth | Slight | Slight | Slight | Moderate | Moderate | On 34th day after inoculation |
| | Aerial mycelium | Few | Few | Few | Moderate | Moderate | |
| | Sporulation | None | None | None | None | Moderate (Deep glaucous-green) | |
| | Chlamydo-spore | None | None | None | None | None | |
| | Color of media | Dark mineral red, bone brown | Dark mineral red, bone brown | Bone-brown | Hay's brown, light seal brown | Prussian red, haematite red | |

TABLE VIII   (*Continued*)

| Agar used | Species | F. arthr. | F. sporotr. | F. anguioid. | F. mart. minus | | Remark |
|---|---|---|---|---|---|---|---|
| | Strains | A—24 | B—30 | C—33 | Jones | Linford | |
| Pea seedling | Growth | Vigorous | Slight | Moderate | Moderate | Moderate | On 26th day after inoculation |
| | Aerial mycelium | Abundant | Few | Moderate | None | Very few | |
| | Sporulation | None | None | None | None | None | |
| | Chlamydospore | None | None | None | None | None | |
| | Color of media | Tawny | Tawny | Ochraceoustawny | Buckthorn brown | Ochraceous tawny | |

TABLE IX.   *Measurements of the conidia produced by Fusarium arthrosporioides on various media*

1.   On sliced potato, culture 53 days old

Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 2 | 18—45 | | | 4 | 2.0 | | |
| 3 | 22—53 | | | 39 | 19.5 | | |
| 4 | 33—60 | | | 81 | 40.5 | | |
| 5 | 35—60 | | | 70 | 35.0 | | |
| 6 | 41—64 | | | 6 | 3.0 | | |
| In total | 18—64 | 46 | 18 | 200 | | 42.09±0.53 | ±7.42 |

Width in micron

| In total | 2.5—4.5 | 3.0 | 116 | 200 | | 3.25±0.02 | ±0.35 |

## 2.  On corn meal agar, culture 45 days old

### Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 0 | 30—65 | | | 7 | 3.5 | | |
| 1 | 45—66 | | | 18 | 9.0 | | |
| 2 | 42—81 | | | 30 | 15.0 | | |
| 3 | 43—77 | | | 52 | 26.0 | | |
| 4 | 41—76 | | | 49 | 24.5 | | |
| 5 | 51—78 | | | 36 | 18.0 | | |
| 6 | 57—70 | | | 7 | 3.5 | | |
| 7 | 61 | | | 1 | 0.5 | | |
| In total | 30—81 | 64 | 13 | 200 | | 60.98±0.53 | ±7.67 |

### Width in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| In total | 2.0—4.0 | 3.0 | 106 | 200 | | 2.97±0.02 | ±0.38 |

## 3.  On banana agar, culture 42 days old

### Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 0 | 21—75 | | | 12 | 6.0 | | |
| 1 | 23—75 | | | 8 | 4.0 | | |
| 2 | 43—71 | | | 12 | 6.0 | | |
| 3 | 39—73 | | | 50 | 25.0 | | |
| 4 | 43—76 | | | 74 | 37.0 | | |
| 5 | 49—78 | | | 41 | 20.5 | | |
| 6 | 65—69 | | | 3 | 1.5 | | |
| In total | 21—78 | 61 | 15 | 200 | | 58.11±0.63 | ±9.17 |

### Width in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| In total | 2.0—4.0 | 3.0 | 155 | 200 | | 2.96±0.01 | ±0.25 |

## 4.   On apricot agar, culture 47 days old

Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 1 | 52—69 | | | 6 | 3.0 | | |
| 2 | 32—66 | | | 45 | 22.5 | | |
| 3 | 37—75 | | | 84 | 42.0 | | |
| 4 | 44—67 | | | 55 | 27.5 | | |
| 5 | 47—60 | | | 10 | 5.0 | | |
| In total | 32—75 | 55 | 20 | 200 | | 54.50±0.44 | ±6.31 |

Width in micron

| In total | 2.0—4.0 | 3.0 | 141 | 200 | | 2.97±0.007 | ±0.10 |
|---|---|---|---|---|---|---|---|

## 5.   On Koji agar, culture 64 days old

Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 1 | 21 | | | 1 | 0.5 | | |
| 2 | 32—50 | | | 6 | 3.0 | | |
| 3 | 30—66 | | | 88 | 44.0 | | |
| 4 | 40—65 | | | 74 | 37.0 | | |
| 5 | 43—60 | | | 23 | 11.5 | | |
| 6 | 45—54 | | | 5 | 2.5 | | |
| 7 | 62—64 | | | 3 | 1.5 | | |
| In total | 21—66 | 48 | 19 | 200 | | 46.57±0.50 | ±7.02 |

Width in micron

| In total | 2.0—4.5 | 3.0 | 123 | 200 | | 3.14±0.02 | ±0.34 |
|---|---|---|---|---|---|---|---|

TABLE X.　*Measurements of the conidia produced by Fusarium*
*sporotrichioides on various media*

### 1.　On soy bean agar, culture 67 days old

Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|-----------|-------|------|-------------------|--------|----------|------|--------------------|
| 1 | 18—25 | | | 7 | 3.5 | | |
| 2 | 19—30 | | | 18 | 9.0 | | |
| 3 | 20—35 | | | 172 | 86.0 | | |
| 4 | 26—30 | | | 3 | 1.5 | | |
| In total | 18—35 | 26 | 40 | 200 | | $26.42\pm0.19$ | $\pm2.70$ |

Width in micron

| In total | 2.5—4.5 | 3.5 | 86 | 200 | | $3.36\pm0.02$ | $\pm0.40$ |
|----------|---------|-----|----|-----|--|----------------|-----------|

### 2.　On kidney bean agar, culture 58 days old

Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|-----------|-------|------|-------------------|--------|----------|------|--------------------|
| 2 | 24—33 | | | 14 | 7.0 | | |
| 3 | 23—41 | | | 140 | 70.0 | | |
| 4 | 29—40 | | | 35 | 17.5 | | |
| 5 | 36—43 | | | 5 | 2.5 | | |
| 6 | 36—41 | | | 6 | 3.0 | | |
| In total | 23—43 | 32 | 24 | 200 | | $32.92\pm0.27$ | $\pm3.90$ |

Width in micron

| In total | 2.5—4.0 | 3.5 | 101 | 200 | | $3.56\pm0.02$ | $\pm0.36$ |
|----------|---------|-----|-----|-----|--|----------------|-----------|

### 3.   On barley seedling agar, culture 64 days old

#### Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 1 | 21 | | | 1 | 0.5 | | |
| 2 | 21—26 | | | 5 | 2.5 | | |
| 3 | 21—35 | | | 184 | 92.0 | | |
| 4 | 31—36 | | | 9 | 4.5 | | |
| 5 | 32 | | | 1 | 0.5 | | |
| In total | 21—36 | 28 | 27 | 200 | | 28.02±0.21 | ±3.06 |

#### Width in micron

| | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| In total | 2.5—4.5 | 3.5 | 111 | 200 | | 3.64±0.02 | ±0.33 |

### 4.   On pea seedling agar, culture 59 days old

#### Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 1 | 18—22 | | | 5 | 2.5 | | |
| 2 | 21—31 | | | 27 | 13.5 | | |
| 3 | 22—37 | | | 164 | 82.0 | | |
| 4 | 28—34 | | | 3 | 1.5 | | |
| 5 | ´30 | | | 1 | 0.5 | | |
| In total | 18—37 | 27 | 33 | 200 | | 27.42±0.22 | ±3.12 |

#### Width in micron

| | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| In total | 2.5—4.0 | 3.0 | 164 | 200 | | 3.06±0.01 | ±0.22 |

## 5.   On potato agar, culture 60 days old

### Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|-----------|-------|------|-------------------|--------|----------|------|--------------------|
| 1 | 13 | | | 1 | 0.5 | | |
| 2 | 19—28 | | | 15 | 7.5 | | |
| 3 | 21—33 | | | 179 | 89.5 | | |
| 4 | 27—33 | | | 5 | 2.5 | | |
| In total | 18—33 | 25 | 37 | 200 | | 27.38±0.18 | ±2.60 |

### Width in micron

| | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|-------|------|-------------------|--------|----------|------|--------------------|
| In total | 2.5—4.0 | 3.0 | 104 | 200 | | 3.23±0.01 | ±0.27 |

TABLE XI.   *Measurements of the conidia produced by Fusarium anguioides on various media*

## 1.   On kidney bean agar, culture 65 days old

### Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|-----------|-------|------|-------------------|--------|----------|------|--------------------|
| 2 | 26 | | | 1 | 0.5 | | |
| 3 | 27—46 | | | 90 | 45.0 | | |
| 4 | 31—46 | | | 75 | 37.5 | | |
| 5 | 33—49 | | | 31 | 15.5 | | |
| 6 | 41—48 | | | 3 | 1.5 | | |
| In total | 26—49 | 39 | 30 | 200 | | 38.23±0.27 | ±3.83 |

### Width in micron

| | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|-------|------|-------------------|--------|----------|------|--------------------|
| In total | 3.0—4.5 | 3.5 | 155 | 200 | | 3.55±0.007 | ±0.106 |

## 2.   On potato agar with 2.5% dextrose, culture 163 days old

### Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 1 | 21 | | | 1 | 1.0 | | |
| 2 | 25—45 | | | 6 | 6.0 | | |
| 3 | 35—40 | | | 5 | 5.0 | | |
| 4 | 34—50 | | | 18 | 18.0 | | |
| 5 | 34—63 | | | 42 | 42.0 | | |
| 6 | 43—68 | | | 18 | 18.0 | | |
| 7 | 50—66 | | | 8 | 8.0 | | |
| 8 | 61 | | | 2 | 2.0 | | |
| In total | 21—68 | 45 | 8 | 100 | | 47.6±0.97 | ±9.74 |

### Width in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| In total | 3.0—5.5 | 4.0 | 36 | 100 | | 4.17±0.05 | ±0.51 |

TABLE XII.   *Measurements of the conidia produced by Fusarium martii var. minus (LINFORD's strain) on various media*

## 1.   On potato agar, culture 68 days old

### Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 0 | 13 | | | 1 | 0.5 | | |
| 1 | 14—25 | | | 45 | 22.5 | | |
| 2 | 18—30 | | | 63 | 31.5 | | |
| 3 | 21—36 | | | 90 | 45.0 | | |
| 4 | 32 | | | 1 | 0.5 | | |
| In total | 13—36 | 25 | 39 | 200 | | 24.84±0.26 | ±3.74 |

### Width in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| In total | 2 5—4.5 | 3.5 | 91 | 200 | | 3.70±0.02 | ±0.36 |

## 2.    On potato agar with 2.5% dextrose, culture 60 days old

### Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 0 | 13—19 | | | 8 | 4.0 | | |
| 1 | 14—27 | | | 100 | 50.0 | | |
| 2 | 21—31 | | | 51 | 25.5 | | |
| 3 | 24—36 | | | 39 | 19.5 | | |
| 4 | 28—34 | | | 2 | 1.0 | | |
| In total | 13—36 | 25 | 26 | 200 | | 23.68±0.31 | ±4.39 |

### Width in micron

| In total | 2.5—5.0 | 4.0 | 104 | 200 | | 3.91±0.03 | ±0.43 |

## 3.    On kidney bean agar, culture 63 days old

### Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 0 | 12—14 | | | 3 | 1.2 | | |
| 1 | 11—27 | | | 112 | 56.8 | | |
| 2 | 18—29 | | | 72 | 32.8 | | |
| 3 | 22—30 | | | 13 | 9.2 | | |
| In total | 11—30 | 22 | 32 | 200 | | 21.30±0.22 | ±3.57 |

### Width in micron

| In total | 2.5—4.5 | 3.5 | 108 | 200 | | 3.45±0.02 | ±0.39 |

## 4.   On raisin agar, culture 63 days old

### Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|-----------|-------|------|-------------------|--------|----------|------|--------------------|
| 0 | 11—14 | | | 4 | 2.0 | | |
| 1 | 15—32 | | | 46 | 23.0 | | |
| 2 | 20—29 | | | 63 | 31.5 | | |
| 3 | 19—33 | | | 78 | 39.0 | | |
| 4 | 25—30 | | | 9 | 4.5 | | |
| In total | 11—33 | 25 | 35 | 200 | | 24.84±0.26 | ±3.70 |

### Width in micron

| | | | | | | | |
|-----------|-------|------|-------------------|--------|----------|------|--------------------|
| In total | 3.0—5.0 | 4.5 | 89 | 200 | | 4.41±0.03 | ±0.45 |

## 5.   On barley seedling agar, culture 66 days old

### Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|-----------|-------|------|-------------------|--------|----------|------|--------------------|
| 0 | 8—14 | | | 6 | 3.0 | | |
| 1 | 12—25 | | | 133 | 66.5 | | |
| 2 | 20—26 | | | 29 | 14.5 | | |
| 3 | 19—30 | | | 32 | 16.0 | | |
| In total | 8—30 | 23 | 28 | 200 | | 20.77±0.31 | ±4.50 |

### Width in micron

| | | | | | | | |
|-----------|-------|------|-------------------|--------|----------|------|--------------------|
| In total | 2.5—4.5 | 3.5 | 99 | 200 | | 3.54±0.02 | ±0.33 |

### 6. On pea seedling agar, culture 60 days old

**Length in micron**

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 0 | 13—14 | | | 2 | 1.0 | | |
| 1 | 15—26 | | | 50 | 25.0 | | |
| 2 | 16—27 | | | 56 | 28.0 | | |
| 3 | 18—32 | | | 88 | 44.0 | | |
| 4 | 25—29 | | | 4 | 2.0 | | |
| In total | 13—32 | 25 | 41 | 200 | | 24.10±0.22 | ±3.23 |

**Width in micron**

| | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| In total | 3.0—5.0 | 4.0 | 114 | 200 | | 4.02±0.02 | ±0.39· |

### 7. On pea agar, culture 64 days old

**Length in micron**

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 0 | 8—13 | | | 6 | 3.0 | | |
| 1 | 9—24 | | | 118 | 59.0 | | |
| 2 | 21—28 | | | 40 | 20.0 | | |
| 3 | 23—30 | | | 35 | 17.5 | | |
| 4 | 31 | | | 1 | 0.5 | | |
| In total | 8—31 | 23 | 30 | 200 | | 21.37±0.28 | ±4.04 |

**Width in micron**

| | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| In total | 2.5—5.0 | 3.5 | 67 | 200 | | 3.58±0.03 | ±0.52 |

### 8.   On soy bean agar, culture 63 days old

Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 0 | 12—13 | | | 2 | 1.0 | | |
| 1 | 14—26 | | | 50 | 25.0 | | |
| 2 | 17—27 | | | 61 | 30.5 | | |
| 3 | 16—31 | | | 75 | 37.5 | | |
| 4 | 23—28 | | | 12 | 6.0 | | |
| In total | 12—31 | 25 | 26 | 200 | | 22.80±0.26 | ±3.76 |

Width in micron

| In total | 3.0—5.5 | 4.0 | 83 | 200 | | 3.98±0.03 | ±0.48 |

TABLE XIII.   *Summary of measurements of the conidia of Fusarium arthrosporioides in culture*

Length in micron

| Septation | Range | Mode | Frequency of Mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 0 | 21—75 | 52 | 3 | 19 | 1.9 | 53.66±2.95 | ±13.54 |
| 1 | 21—75 | 56 | 3 | 33 | 3.3 | 54.54±2.02 | ±11.65 |
| 2 | 18—81 | 55 | 10 | 97 | 9.7 | 53.73±1.03 | ±10.20 |
| 3 | 22—77 | 53 | 14 | 313 | 31.3 | 52.72±0.63 | ±11.29 |
| 4 | 33—76 | 58 | 17 | 333 | 33.3 | 52.48±0.50 | ± 9.16 |
| 5 | 35—78 | 60 | 11 | 180 | 18.0 | 54.79±0.67 | ± 9.06 |
| 6 | 41—70 | 64 | 2 | 21 | 2.1 | 57.45±2.18 | ± 9.78 |
| 7 | 61—64 | 62 | 1 | 4 | 0.4 | 62.50±0.55 | ± 1.11 |
| In total | 18—81 | 55 | 40 | 1000 | | 52.57±0.32 | ±10.41 |

Width in micron

| In total | 2.0—4.5 | 3.0 | 641 | 1000 | | 3.06±0.01 | ±0.35 |

TABLE XIV.   *Summary of measurements of the conidia of*
*Fusarium sporotrichioides in culture*

Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 1 | 18—25 | 25 | 3 | 14 | 1.4 | 21.28±0.70 | ±2.63 |
| 2 | 19—33 | 25 | 16 | 79 | 7.9 | 25.59±0.33 | ±2.94 |
| 3 | 20—41 | 26 | 113 | 839 | 83.9 | 28.09±0.12 | ±3.47 |
| 4 | 26—40 | 33 | 9 | 55 | 5.5 | 33.58±0.45 | ±3.40 |
| 5 | 30—43 | 37 | 1 | 7 | 0.7 | 36.71±1.58 | ±4.19 |
| 6 | 36—41 | 41 | 2 | 6 | 0.6 | 39.16±0.72 | ±1.77 |
| In total | 18—43 | 26 | 125 | 1000 | | 28.23±0.12 | ±3.96 |

Width in micron

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| In total | 2.5—4.5 | 3.5 | 415 | 1000 | | 3.37±0.01 | ±0.38 |

TABLE XV.   *Summary of measurements of the conidia of*
*Fusarium anguioides in culture*

Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 1 | 21 | 21 | 1 | 1 | 0.3 | | |
| 2 | 25—45 | 32 | 2 | 7 | 2.3 | 32.85±3.08 | ±8.16 |
| 3 | 27—46 | 39 | 14 | 95 | 31.7 | 34.61±0.37 | ±3.60 |
| 4 | 31—50 | 39 | 16 | 93 | 31.0 | 39.17±0.38 | ±3.74 |
| 5 | 33—63 | 44 | 10 | 73 | 24.3 | 45.41±0.82 | ±7.05 |
| 6 | 41—68 | 48 | 3 | 21 | 7.0 | 50.95±1.73 | ±7.96 |
| 7 | 50—66 | 60 | 2 | 8 | 2.7 | 62.50±2.06 | ±5.83 |
| 8 | 60 | | 2 | 2 | 0.7 | | |
| In total | 21—68 | 39 | 31 | 300 | | 41.35±0.45 | ±7.80 |

Width in micron

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| In total | 3.0—5.5 | 3.5 | 176 | 300 | | 3.76±0.02 | ±0.50 |

TABLE XVI.  *Summary of measurements of the conidia of Fusarium martii var. minus (LINFORD'S STRAIN) in culture*

| Length in micron | | | | | | | |
|---|---|---|---|---|---|---|---|
| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
| 0 | 8 −19 | 13 | 8 | 32 | 2.0 | 12.50 ± 0.43 | ± 2.47 |
| 1 | 9 − 32 | 20 | 90 | 654 | 40.9 | 20.23 ± 0.11 | ± 3.07 |
| 2 | 16 − 31 | 25 | 93 | 435 | 27.2 | 23.51 ± 0.11 | ± 2.48 |
| 3 | 16 − 36 | 25 | 91 | 450 | 28.1 | 26.37 ± 0.14 | ± 3.12 |
| 4 | 23 − 34 | 25 | 7 | 29 | 1.7 | 27.13 ± 0.43 | ± 2.35 |
| In total | 8 − 36 | 25 | 218 | 1600 | | 22.91 ± 0.10 | ± 4.09 |

| Width in micron | | | | | | | |
|---|---|---|---|---|---|---|---|
| In total | 2.5 − 5.5 | 4.0 | 611 | 1600 | | 3.88 ± 0.01 | ± 0.51 |

TABLE XVII.  *Measurements of the conidia produced by Fusarium arthrosporioides under natural conditions*

| Length in micron | | | | | | | |
|---|---|---|---|---|---|---|---|
| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
| 0 | 19 −- 57 | | | 26 | 4.3 | | |
| 1 | 13 − 56 | | | 35 | 5.8 | | |
| 2 | 22 − 59 | | | 37 | 6.2 | | |
| 3 | 18 - 66 | | | 94 | 15.7 | | |
| 4 | 37 − 60 | | | 102 | 17.0 | | |
| 5 | 39 − 66 | | | 252 | 42.0 | | |
| 6 | 48 − 63 | | | 36 | 6.0 | | |
| 7 | 58 − 66 | | | 15 | 2.5 | | |
| 8 | 62 − 67 | | | 3 | 0.5 | | |
| In total | 13 − 67 | 55 | 44 | 600 | | 49.80 ± 0.35 | ± 8.78 |

| Width in micron | | | | | | | |
|---|---|---|---|---|---|---|---|
| In total | 2.5 − 4.5 | 3.5 | 223 | 600 | | 3.43 ± 0.01 | ± 0.46 |

TABLE XVIII. *Measurements of the conidia produced by Fusarium sporotrichioides under natural conditions*

Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 0 | 18—32 | | | 4 | 1.3 | | |
| 1 | 25—31 | | | 2 | 0.7 | | |
| 2 | 30 – 37 | | | 8 | 2.7 | | |
| 3 | 21—45 | | | 262 | 87.3 | | |
| 4 | 34—43 | | | 22 | 7.3 | | |
| 5 | 39—42 | | | 2 | 0.7 | | |
| In total | 18—45 | 36 | 56 | 300 | | 35.67±0.19 | ±3.32 |

Width in micron

| | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| In total | 2.0—4.5 | 3.0 | 166 | 300 | | 3.16±0.02 | ±0.35 |

TABLE XIX. *Measurements of the conidia produced by Fusarium anguioides under natural conditions*

Length in micron

| Septation | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| 0 | 39—81 | | | 14 | 4.7 | | |
| 1 | 52—81 | | | 12 | 4.0 | | |
| 2 | 42—77 | | | 18 | 6.0 | | |
| 3 | 47—86 | | | 31 | 10.3 | | |
| 4 | 48—91 | | | 61 | 20.3 | | |
| 5 | 40—93 | | | 121 | 40.3 | | |
| 6 | 53—92 | | | 31 | 10.3 | | |
| 7 | 73—84 | | | 7 | 2.3 | | |
| 8 | 70—82 | | | 5 | 1.7 | | |
| In total | 39—93 | 75 | 18 | 300 | | 71.00±0.56 | ±9.70 |

Width in micron

| | Range | Mode | Frequency of mode | Number | Per cent | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|
| In total | 2.5—4.0 | 3.0 | 207 | 300 | | 3.02±0.01 | ±0.29 |

## Taxonomic Characters

JONES (1923) has given a review of the literature on the *Fusaria* occurring on pea up to 1923, stating that the five species and one variety have been already recorded in Europe and America. He has then described one more variety under the name of *Fusarium martii* APP. et WR. var. *pisi* JONES, which seems to be identical with *F. martii* var. *minus* SHERB. In addition to the above mentioned, Dr. WOLLENWEBER has kindly informed me that eight more *Fusaria* had been isolated from pea and determined by himself within the last two decades. All of these *Fusaria* belonging to the following sections of the genus *Fusarium* may be tabulated as follows :—

Section Roseum :—

F. *viticola* THUEM., on wilted pea, Sweden

F. *avenaceum* (Fr.) SACC., causing foot disease, Germany

F. *herbarum* (Corda) FR., on hypocotyl and upper part of stem, Norway

F. *herbarum* var. *gibberelloides* WR., on diseased seed, Germany.

Sectien Discolor :—

F. *culmorum* (W. G. SMITH) SACC., on wilted pea, Sweden.

Section Eupionnotes :—

F. *dimerum* PENZIG, on wilted pea, Sweden.

Section Martiella :—

F. *martii* APP. et WR., causing foot disease, Germany

F. *martii* var. *minus* SHERB., causing stem and root rot, U.S.A.

Section Gibbosum : —

F. *falcatum* APP. et WR., causing foot disease, Europe.

Section Elegans :—

F. *vasinfectum* ATK. var. *pisi* VAN HALL, causing ST. JOHN's disease, Holland

F. *redolens* WR., causing foot disease, Germany

F. *oxysporum* SCHLECHT., causing wilt disease, U.S.A.

F. *orthoceras* APP. et WR., on wilted pea, U.S.A.

F. *conglutinans* WR., on wilted pea, U.S.A.

F. *blasticola* ROSTRUP, causing foot disease, Germany.

Of our *Fusaria*, *F. arthrosporioides* and *F. anguioides* may be placed under the section Roseum,[1] which contains the members of the

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(1) Dr. WOLLENWEBER states in his information, "If the mere presence of arthrosporial conidia is the criterium for *Arthrosporiella*, then all of the well known species of *Roseum* belong to *Arthrosporiella*, which must be discarded then as a Section on account of the priority of *Roseum*."

section Arthrosporiella, while *F. sporotrichioides* belongs to the section Sporotrichiella.   So far as can be ascertained by the writer, no record has been found in literature that states the occurrence of any of our species of *Fusarium* on pea.


## *Fusarium arthrosporioides* SHERB.

This species was first described by SHERBAKOFF (1915) who found it in discolored tissues of potato tubers.   Dr. WOLLENWEBER says that he has isolated this fungus from carrots, and that he has discovered it also on *Claviceps microcephala* of *Molinia coerulea*, on the wounded peridia of *Scleroderma*, on dead stems of *Urtica dioica*, and also on woody parts of vines of *Rubus idaeus*.

Our strain of *F. arthrosporioides* has, as a rule, no typical sporotrichial microconidia which SHERBAKOFF has reported for this type species, and, therefore, it agrees very much with his variety *F. arthrosporioides* var. *asporotrichium* but differs by the absence of sporotrichial sporodochia.   According to the *Fusarium* Conference held in Madison, 1924 this variety is, however, considered to be identical with *F. arthrosporioides*.   The taxonomic characters of our strain obtained through cultural experiments are as follows :

Arthrosporial microconidia cylindrical with rounded ends or slightly attenuated toward apex, straight or curved ; macroconidia with ellipsoidal rarely parabolic curvature, more or less gradually pointed toward both ends, nearly cylindrical in middle half of their length, usually somewhat distinctly pedicellate, 0 to 7-septate, predominantly 4-septate (under natural conditions 0 to 8-septate, typically 5-septate), 18 to 81 by 2.0 to 4.5 $\mu$, 52.57$\pm$0.32 by 3.06$\pm$0.01 $\mu$ in mean (under natural conditions 13 to 67 by 2.5 to 4.5 $\mu$, 49.80$\pm$0.35 by 3.43$\pm$0.01 $\mu$ in mean), color in sporodochia usually light ochraceous buff ; substratum on potato-dextrose agar pinkish buff, clay colored to pompian red plectenchymatic cushions on steamed rice, color on rice avellaneous to wood brown ; no sclerotia ; no chlamydospores ; aerial mycelium usually well developed, white to vinaceous ; zonation marked on some media.

Habitat :   On wilting stem base of *Pisum sativum* L., Kyoto, Japan.

## *Fusarium sporotrichioides* SHERB.

SHERBAKOFF (1915) has found this fungus together with *F. solani* and *F. oxysporum* on rotted tubers of potato. Dr. WOLLENWEBER states that he has found the same fungus on dead stems of *Urtica dioica*, on the cortex of *Nyssa aquatica*, on rotting apple fruits, on the bases of diseased wheat, and also on a diseased spot of stem of *Erythrina*. The general taxonomic characters of our strain are as follows:

Sporotrichial microconidia[1] (Fig. 1 in text) generally unicellular, pear- or lemon-shaped, averaging $11.7 \times 5.8$ ($7-14 \times 4.5-7.0$) $\mu$ in size, sometimes 1-septate, averaging $15 \times 5.8$ ($13-20 \times 4.5-6.5$) $\mu$; sporodochial, pionnotal macroconidia with ellipsoidal dorsal curve, gradually attenuated toward both ends, often somewhat more distinctly curved near apex, more or less broader in the middle, pedicellate, 1 to 6-septate, mostly 3-septate, 6-, 5-, 1-septate rare (under natural conditions 0 to 5-septate, mostly 3-septate, 1-, 5-, 0-septate rare), 18 to 43 by 2.5 to 4.5 $\mu$, $28.23 \pm 0.12$ by $3.37 \pm 0.01$ $\mu$ in mean (under natural conditions 18 to 45 by 2.0 to 4.5 $\mu$, $35.67 \pm 0.19$ by $3.02 \pm 0.01$ $\mu$ in mean), color in pseudopionnotes and sporodochia ochraceous buff, salmon buff or grenadine



Fig. 1. Sporotrichial microconidia of *Fusarium sporotrichioides*. (After WOLLENWEBER).

pink; substratum on potato-dextrose agar naples yellow, on raisin agar spinel red to diamine brown, ochraceous orange to ochraceous tawny plectenchymatic cushions on steamed rice, color on rice ivory yellow to honey yellow; chlamydospores in mycelium intercalary, in chains naples yellow or spinel red, 7 to 11 $\mu$ in diameter; no sclerotia; aerial mycelium usually scantily developed, vinaceous to cartridge buff color; zonation marked on some media.

Habitat: On wilted stem of *Pisum sativum* L., Kyoto, Japan.

## *Fusarium anguioides* SHERB.

This is the species that was first discovered by SHERBAKOFF (1915) on rotted tubers of potato in association with *F. arcucsporum*. Later

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(1) The writer owes a debt to Dr. WOLLENWEBER for the description of this microconidia.

REIKING and WOLLEWEBER (1927) have also isolated this organism in Honduras and Jamaica from the petioles of dead leaves of undetermined plant as well as from dried pods of pigeon pea (*Cajanus indicus*). They were also able to find this in soil or on plant débris. The general taxonomic characters of our strain are as follows :

Pseudopionnotal macroconidia gradually pointed toward both ends, generally more or less broader in the middle, curved, rarely straight, typically pedicellate, sometimes apedicellate, 1 to 8-septate, mostly 3-septate, often also 4- and 5-septate, 1- and 8-septation very rare, (under natural conditions 0 to 8-septate, typically 5-septate), 21 to 68 by 3.0 to 5.5 $\mu$, 41.35±0.45 by 3.76±0.02 $\mu$ in mean (under natural conditions 39 to 93 by 2.5 to 4.0 $\mu$, 71.00±0.56 by 3.02±0.01 $\mu$ in mean), in pseudopionnotes light salmon orange color; substratum on potato-dextrose agar ochraceous buff, on raisin agar eugenia red, on steamed rice plectenchymatic cushion ochraceous orange to zinc orange, color on rice warm buff to cinnamon buff; chlamydospores in mycelium intercalary, single or in chains, cartridge buff to cream buff, 8 $\mu$ wide in average; no sclerotia; aerial mycelium moderately developed, white, pinkish buff to pallid mouse gray; zonation usually none.

Habitat : On wilting stem base of *Pisum sativum* L., Kyoto, Japan.

## Résumé

1. In the vicinity of Kyoto three different species of *Fusarium*, *F. arthrosporioides* SHERB., *F. sporotrichioides* SHERB., and *F. anguioides* SHERB. were isolated from the affected parts of the wilt disease of pea. The identifications of these *Fusaria* were made through the help rendered me by Dr. H.W. WOLLENWEBER.

2. The results of eight inoculation experiments so far carried on have shown that our three *Fusaria* were all parasitic on pea seedlings, and that *F. arthrosporioides* showed most severe infection power, while *F. sporotrichioides* and *F. anguioides* less. In comparing the pathogenicity of our *Fusaria* with that of *F. martii* var. *minus* (JONES' strain), the latter showed the highest percentage of damages but much less percentage of heavy damages than in *F. arthrosporioides*.

3. Essential cultural characters of our *Fusaria* and *F. martii* var. *minus* (JONES' and LINFORD's strains) are given in the accompanying table in a summarized fashion. Measurements of the conidia produced by our three *Fusaria* as well as *F. martii* var. *minus* in culture are also tabulated.

4. The summary of the taxonomic characters derived from the results of cultural experiments on our *Fusaria* will be seen in the last pages of this paper.

May 30, 1928.

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MORIOKA, JAPAN.

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**Explanation of Plates**

PLATE XVII

Wilting pea seedlings following soil inoculation with a strain of *F. arthrosporioi-des* (reduced in size).

From above, Sensation, Gladstone, Duke of Albany.   Pot numbers 89, 91, and 94, controls.

PLATE XVIII

Affected Alaska pea seedlings following soil inoculation with various species of *Fusarium* (×4).

Fig. 1, control; Fig. 2, inoculated with *F. arthrosporioides*; Fig. 3, with *F. anguioides* (notice rootlets being newly produced in the lesion as in the case of *F. martii* var. *minus*); Fig. 4, with the JONES' strain of *F. martii* var. *minus*.

PLATE XIX

The figures were in all cases, unless otherwise specified, magnified 800 times.

Figs. 1–9. *F. arthrosporioides*.  1, Conidia from sporodochia of 40 days-old culture on Koji agar; 2, conidia from sporodochia on stem base of wilting pea under natural conditions; 3, conidia from sporodochia 40 days-old culture on potato agar; 5, conidia from sporodochia of 39 days-old culture on corn meal agar; 6, conidia from sporodochia of 39 days-old culture on apricot agar; 7 (×600), 8 (×500), and 9 (×500), microconidium formation in hanging-drop culture after 20–42 hours.

Figs. 10–13. *F. sporotrichioides*.  10, Conidia from pseudopionnotes of 69 days-old culture on soy bean agar; 11, conidia from sporodochia on the wilting pea stem under natural conditions; 12, conidia from pseudopionnotes of 73 days-old culture on raisin agar; 13, chlamydospores from 73 days-old culture on raisin agar.

Figs. 14–17. *F. anguioides*.  14, Conidia from sporodochia on the wilting pea stem base under natural conditions; 15, conidia from pseudopionnotes of 66 days-old culture on kidney bean agar; 16, conidia from pseudopionnotes of 77 days-old culture on potato-dextrose agar.

PLATE XX

All the cultures were on steamed rice in ERLENMEYER flasks which were kept in an incubator of 30° C. and 139 days-old.

Fig. 1. *F. arthrosporioides*; Fig. 2.  *F. sporotrichioides*.  Fig. 3. *F. anguioides*. Fig. 4. The JONES' strain of *F. martii* var. *minus*.

PLATE XXI

All the cultures were on potato agar containing 2.5% dextrose in test tubes which were kept in an incubator of 30° C. and 81 days-old.

The above rank is front view and the lower, view from beneath.  Figs. 1 and 6, *F. arthrosporioides*.  Figs. 2 and 7, *F. sporotrichioides*.  Figs. 3 and 8, *F. anguioides*. Figs. 4 and 9, the Linford's strain of *F. martii* var. *minus*.  Figs. 5 and 10, the JONES' strain of the same.
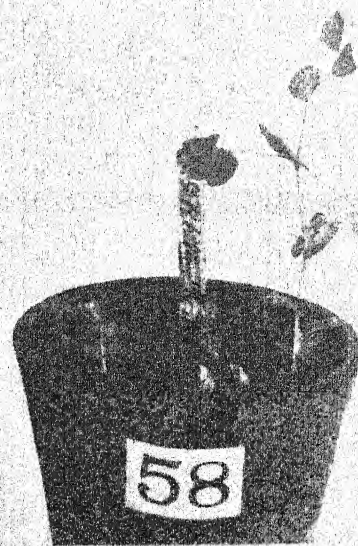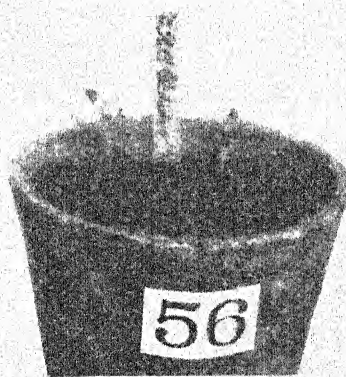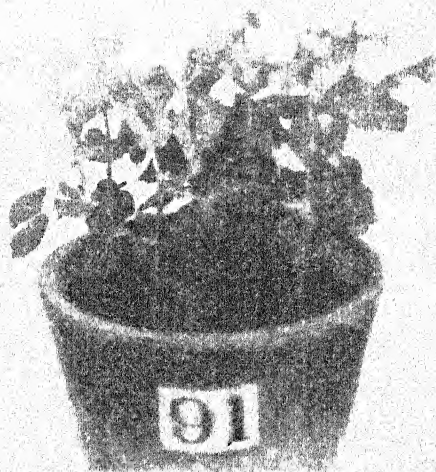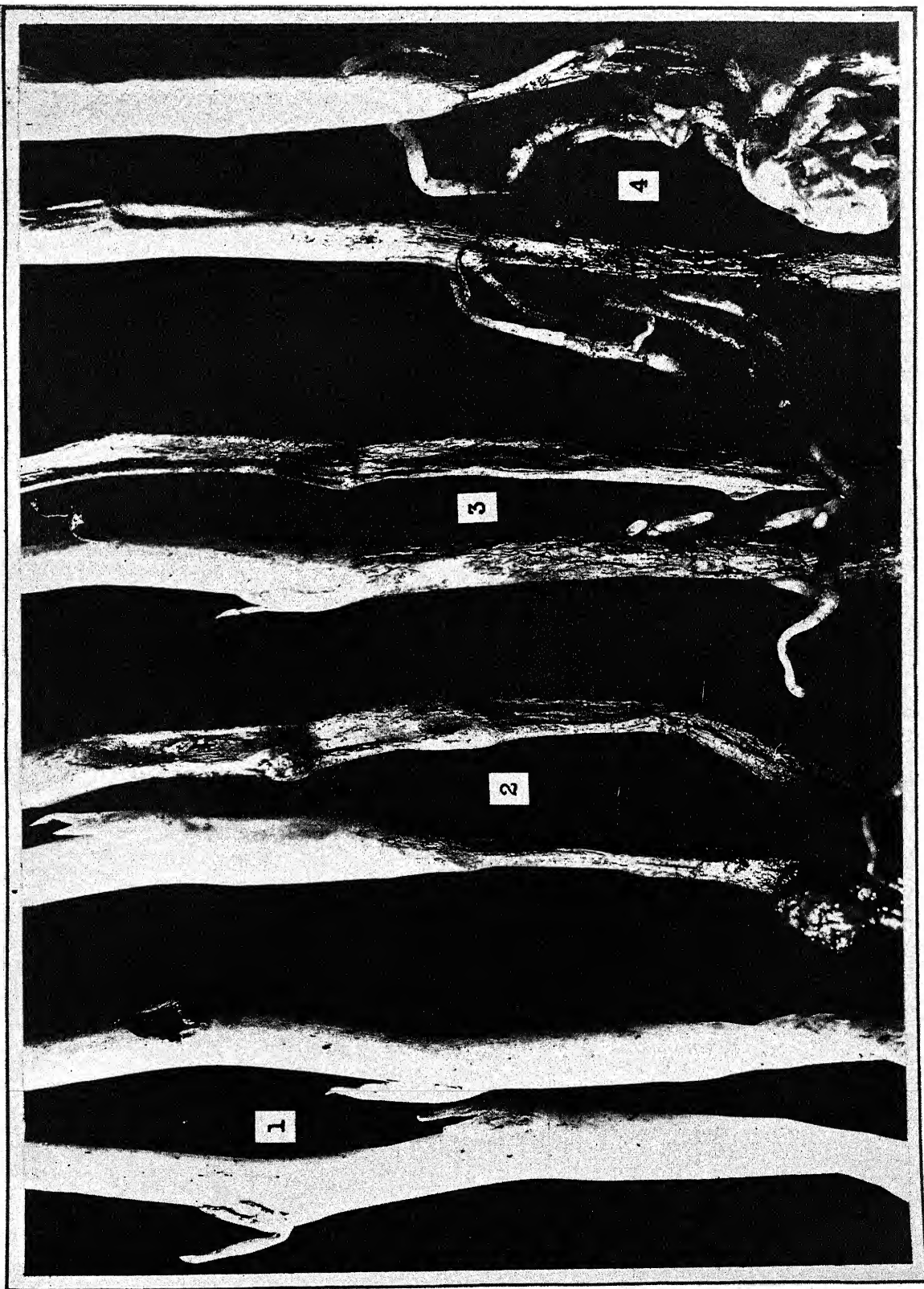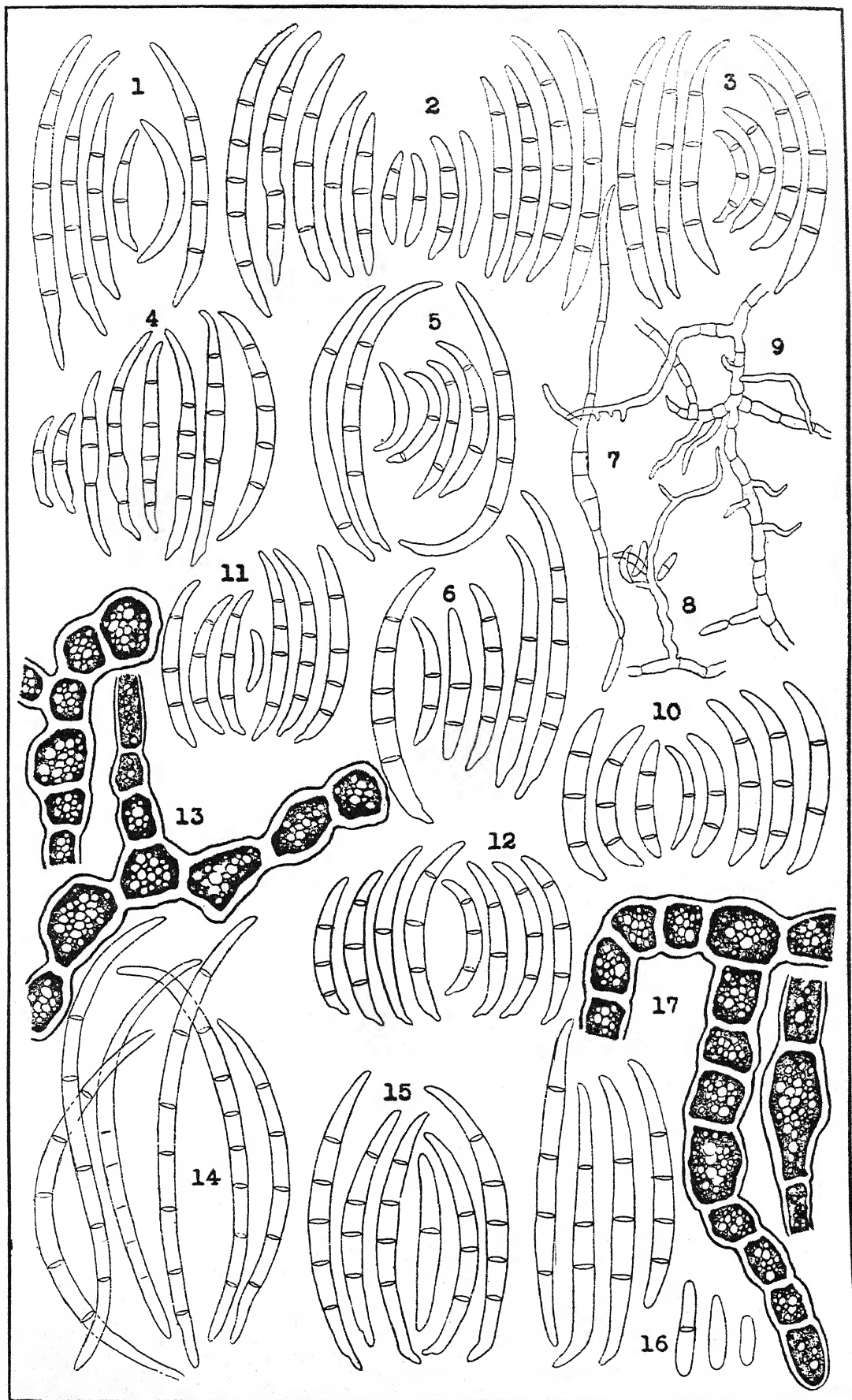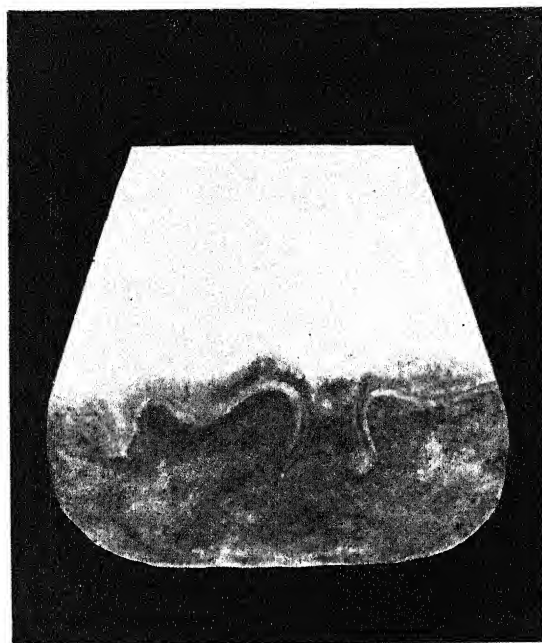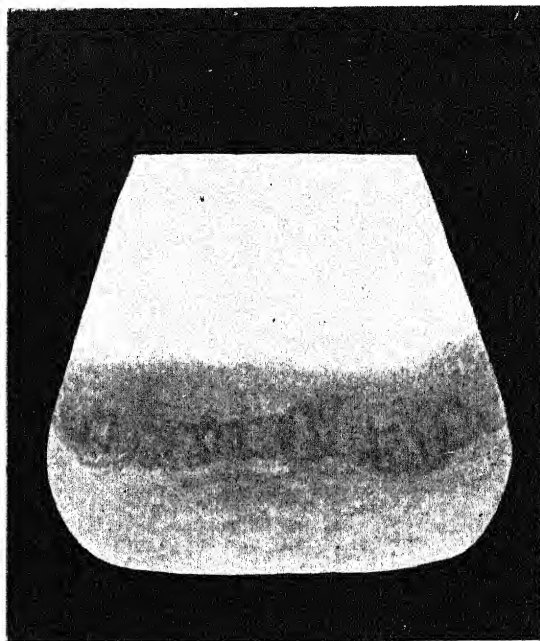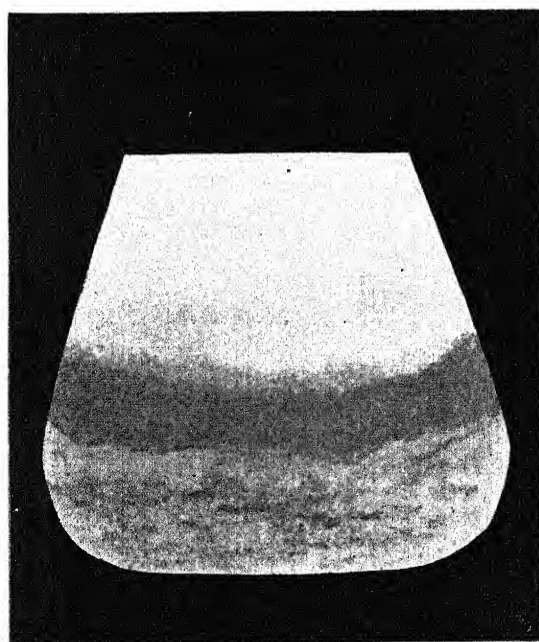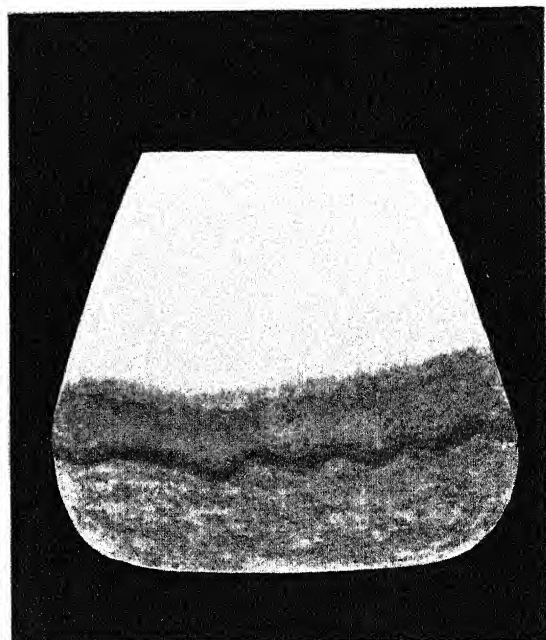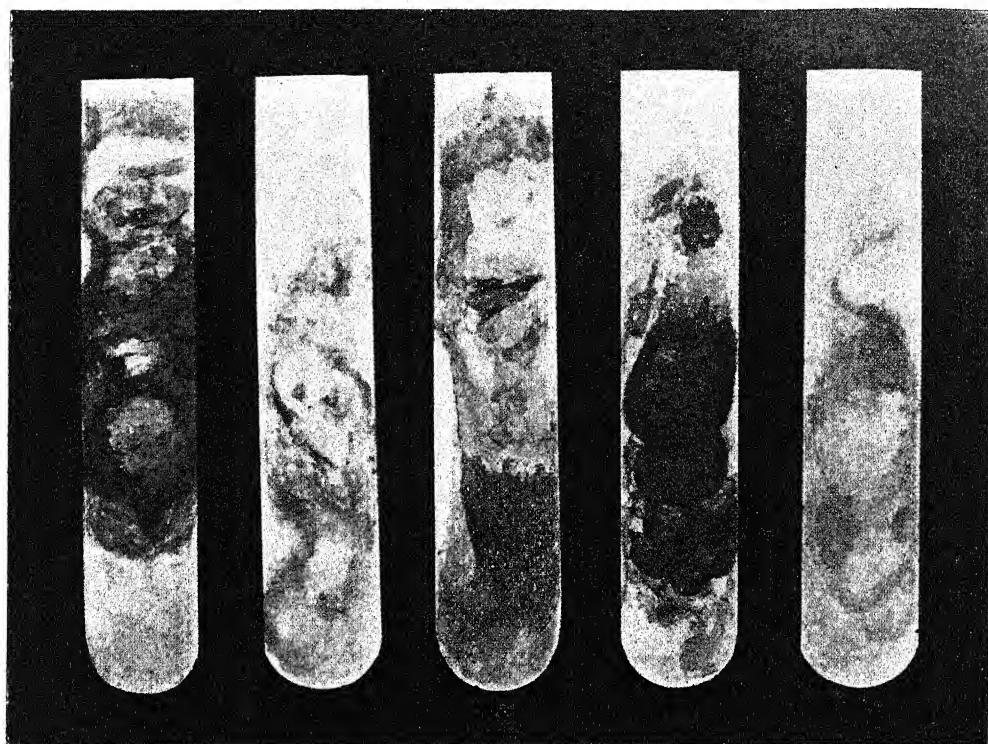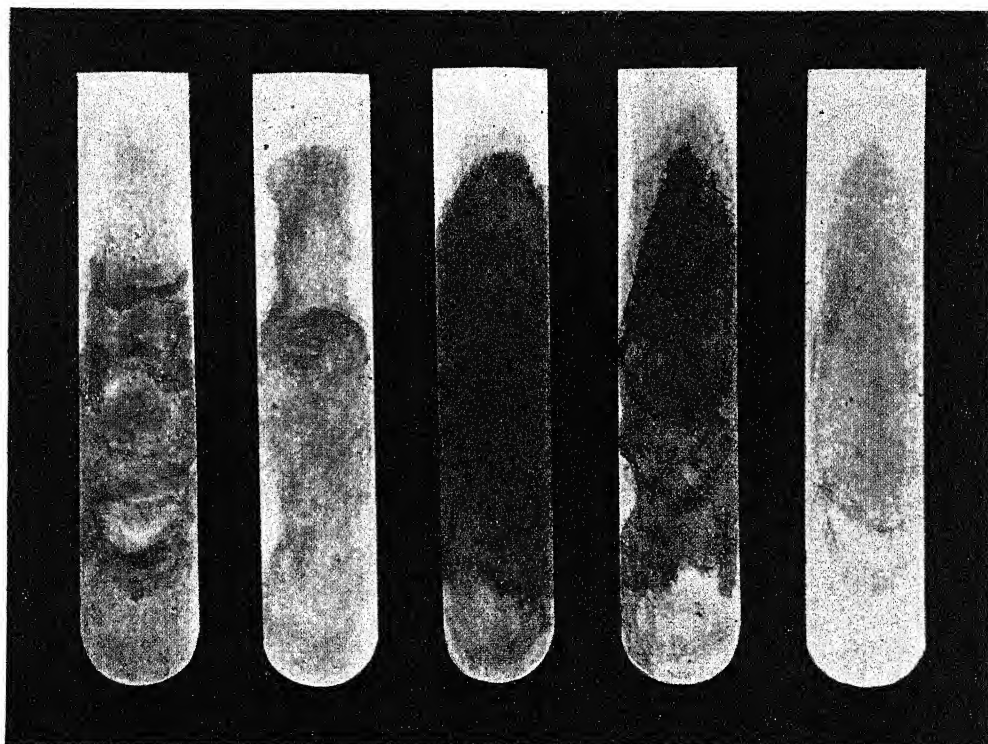
PLATE XVII

PLATE XVIII

PLATE XIX

PLATE XX



1

2

3

4

K. TOGASHI and E. TSUKAMOTO del.

PLATE XXI



1  2  3  4  5

6  7  8  9  10

K. TOGASHI and E. TSUKAMOTO del.

# Studien über die Vererbung der Blütenfarbe bei Portulaca grandiflora

## III. Mitteilung. Mosaikfarbe

Von Seiitirô IKENO

Hierzu Tafel XXII

Die in der vorliegenden Abhandlung mitgeteilten Versuchsresultate über die Erblichkeit der Mosaikblütenfarbe bei *Portulaca grandiflora* enthalten vielerlei Tatsachen, welche nach dem gegenwärtigen Stande der Wissenschaft kaum einwandfrei gedeutet werden können, was kein Wunder ist, wenn man bedenkt, dass auch bei den bisher von vielen Forschern studierten Mosaikpflanzen verschiedenster Art ihr Erblichkeitsverhalten in manchen Fällen noch unerklärt bleibt. Die vorliegende Mitteilung soll deshalb vornehmlich als eine Anführung der beobachteten einzelnen Tatsachen betrachtet werden, wenn es auch versucht wurde, einige Deutungen der erhaltenen Resultate hinzuzufügen.

Meine unten näher zu erläuternde Versuchsreihe ist ursprünglich aus einem einzigen Individuum mit mosaikartig weiss und purpurn („magenta" der Engländer) gefärbten Blüten hervorgegangen. Vor vielen Jahren habe ich es von einem Gärtner in Tôkyô bekommen und sein Ursprung, ob es nach irgend einer Kreuzung oder mutativ entstanden ist, ist ganz unbekannt. Wie man in Taf. XXII, Fig. 1 sieht, ist dabei die Grundfarbe der Kronenblätter weiss mit einem leichtpurpurnen Hauch ; sie sind durch den Besitz von zahlreichen feinen Flecken und Streifen ausgezeichnet, welche im allgemeinen schwachpurpurn sind und worunter einige ausnahmsweise ziemlich intensiv gefärbt sein können. Solche Blüte werde ich unten *schwachpurpurne Mosaikblüte* nennen. Im Gegensatz dazu gibt es diejenige, von der fast alle Flecken und Streifen nicht nur viel intensiver gefärbt, sondern auch im allgemeinen grober und deshalb viel ansehnlicher sind als bei schwachpurpurner Blüte ; solche Blüte wird unten *starkpurpurne Mosaikblüte* genannt (Taf. XXII, Fig. 2). Bei der letzteren Blütenart können oftmals wenige Streifen ziemlich breit sein (Taf. XXII, Fig. 2), ja sogar nicht selten sind unter fünf Kronenblättern einige ganzfarbig-

oder teilweise ganzfarbigpurpurne nachzuweisen (Fig. 3). Die Staub-
fäden und Griffel sind schwach rot. Die Herzflecke am Grunde jedes
Kronenblattes sind rot, unansehnlich, wenn auch etwas deutlicher bei
schwach- als bei starkfarbigen Blüten.[1] Beiderlei Arten von Mosaik-
blüten kommen niemals an einem und demselben Individuum gemischt
vor, weshalb man nach den an denselben getragenen Blütenarten
*schwach-* oder *starkpurpurne Mosaikpflanzen* unterscheiden kann. Die
Stämme und Blätter der Mosaikpflanzen kann man auch als mosaik-
artig gefärbt betrachten, denn wenn sie im ganzen grün sind, sind sie
durch den Besitz von einzelnen feinen roten Streifen ausgezeichnet:
im Stamme und Äste gehen sie ihrer ganzen Länge nach durch und im
Blatte sind sie an ihrer unteren Fläche als longitudinale Streifen sicht-
bar. Der Färbungsgrad dieser Streifen ist verschieden und im Falle
von schwachpurpurnen Mosaikpflanzen sind sie nicht selten kaum
sichtbar. Die Unterscheidung der Mosaikblüten und dementsprechend
auch der Mosaikpflanzen nach diesen zweierlei Arten, schwach- und
starkpurpurn, bietet in der Regel keine besondere Schwierigkeit, denn
die Grenze zwischen beiderlei Arten von Mosaikblüten ist ziemlich
scharf und es gibt keine Übergangsformen, welche diese Unterschei-
dung verwischen könnten.

Im Verlaufe meiner Versuche sind aus den Pflanzen mit purpurnen
Mosaikblüten solche mit orangefarbigen neu entstanden, von denen
später eingehend die Rede sein wird (vgl. S. 199 ff.). Doch möchte ich
schon jetzt mitteilen, dass es bei denselben auch zweierlei Arten gibt,
gerade wie bei purpurnen Pflanzen, nämlich schwach- und stark-
gefärbte Blüten bzw. Pflanzen, je nachdem die Flecken und Streifen
an den Blüten schwach oder stark orangefarbig sind (vgl. Fig. 4,
schwach und Fig. 5 und 6, stark), deren Grenze ebenso ziemlich
scharf sind, wie bei den purpurnen Blüten oder Pflanzen.[2] Auch
können bei solchen Blüten einige Kronenblätter ganzfarbig- oder teil-
weise ganzfarbigorange sein (Fig. 6 und 7). Die Grundfarbe der
letzteren ist weiss mit einem leichten orangefarbigen Hauch. Die
Herzflecken sind purpurn und ziemlich ansehnlich (Fig. 4–6). Die

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(1) Diese Herzflecke sind in Fig. 1–3 nicht sichtbar.
(2) Es ist kaum nötig zu bemerken, dass jede Art (stark- und schwachfarbig)
sowohl der purpurnen als orange Mosaikpflanzen unter sich selbst auch kleine Fluk-
tuationen des Färbunggrades aufweist. Die letzteren sind jedoch so unbedeutend,
dass sie die Unterscheidung zwischen den oben angedeuteten schwach- bzw. stark-
farbigen Klassen verwischen könnten. Z.B. zeigen Fig. 5 und 6 in Taf. XXII zwei stark-
orange Mosaikblüten, welche in ihrem Färbungsgrade etwas voneinander verschie-
den sind, doch wird man leicht sehen können, dass die Blüten in Fig. 5–6 einerseits
und dieselbe in Fig. 4 andererseits zu verschieder Art gehören müssen.

Staubfäden und Griffel sind rot. Die Stämme und Blätter sind grün und durch wenige feine rote Streifen durchsetzt, ganz in derselben Weise wie bei den purpurnen Mosaikblüten.

## Selbstbefruchtung

Wie oben mitgeteilt, sind meine ganze Versuche aus einem einzigen Individuum mit schwachpurpurnen Mosaikblüten ausgegangen. Die Selbstbefruchtung derselben geschah zuerst im Sommer 1920; die Resultate davon, wie sie 1921 nachgewiesen, waren wie in Tab. I.

<div align="center">

TABELLE I (1921)

</div>

$$\text{Nachkommenzahl} \begin{cases} pm & PM & w \\ 13 & 1 & 4 \\ & 14(=78\%) & (=22\%) \end{cases}$$

(*pm*=schwachpurpurn,
*PM*=starkpurpurn, *w*=weiss)

<div align="center">

TABELLE II. B (1922)[1]

</div>

| Mosaik | $W$(= weissartig) | $w$ | Summe |
|---|---|---|---|
| | a. Aus *pm* | | |
| 50 | 3 | 7 | 60 |
| | 53 (=90%) | (=10%) | |
| | b. Aus *PM* | | |
| 84 (=100%) | | | 84 |
| | c. Aus *w* | | |
| | 3 (=75%) | 1 (=25%) | |

Wie man dabei sieht, ist aus einem Individuum mit schwachpurpurnen Mosaikblüten (=*pm*) ausser seinesgleichen noch eine Anzahl von Nachkommen mit weissen Kronenblättern (=*w*) herausgespalten; auch es ist zu bemerken, dass zugleich eine starkpurpurne Mosaikpflanze (=*PM*) dabei neuentstanden ist.

Jedes Nachkommen dieser dreierlei Arten wurde 1921 selbstbefruchtet. Die Resultate 1922 stehen wie in Tab. II.

Bei den in der Tabelle II als *W* (=weissartig) bezeichneten Nachkommen lässt an der ganzen Krone, deren Grundfarbe weiss ist, nur einige ziemlich starkpurpurne Streifen oder Flecken erkennen, nicht selten bloss einen einzigen kurzen Streifen, weshalb die Blüte dieser Art von Nachkommen wohl

(1) Jede in der vorliegenden Abhandlung angeführte Tabelle wird mit wenigen Ausnahmen zu A und B eingeteilt. Die A-Tabelle gibt eingehend die Resultate aus jedem einzelnen Individuum an, während die entsprechende B-Tabelle die Gesamtresultate aus einer Anzahl von Individuen zeigt. Die B-Tabellen befinden sich im Texte, während die A-Tabellen, welche besonders für diejenigen, die eingehender die Resultate studieren wollen, angerichtet sind, im Anhange zum Ende der Abhandlung angegeben sind.

auch durch Fig. 7 (Pl. II) meiner 1921 publizierten Abhandlung[1] dargestellt werden konnte.   Hinzuzufügen ist noch, dass die Pflanzen mit weissen Blüten 1921 (=$w$) ausser ihresgleichen eine andere Art Nachkommen gaben, nämlich weissartig (=$W$); dass diese weissen Individuen höchst wahrscheinlich keine wirkliche weisse sein mögen, werde ich bald unten erläutern (S. 193).   Weiter ist es zu bemerken, dass einige aus starkpurpurnen Mosaik-Eltern angekommene Nachkommen[2] einzelne rote Äste produziert haben, welche ganzfarbigpurpurne Blüten tragen, wozu vgl. unten (S. 194).

1922 wurde unter den Nachkommen aus den Mosaikpflanzen keine Unterscheidung zwischen schwach- und starkfarbigen gemacht, aber seit 1923 wurden diese zweierlei Arten von Nachkommen immer besonders berechnet. Die Resultate dieses letzteren Jahrganges lautet somit wie in Tab. III.

Die oben erwähnten Versuchsresultate des Jahrganges 1921-1923, zusammen mit einigen noch nicht angeführten Ergänzungsangaben, können wie folgt zusammengefasst werden.

1. Die schwachpurpurnen Mosaikpflanzen geben eine Nachkommenschaft, welche weiss, stark- und schwachfarbige enthält, und zwar weit mehr schwachfarbige als starkfarbige (z. B. in der Tabelle III. B,a 99 bzw. 29, d.h. mehr als 3mal). Das letztere gibt dagegen eine Nachkommenschaft, welche bloss stark- und schwachfarbige enthält, und zwar beide ungefähr zu gleichen Teilen (z.B. in der Tabelle III.

TABELLE III. B (1923)

| $pm$ | $PM$ | $W$ | $gfp$ | $w$ | Summe |
|------|------|-----|-------|-----|-------|
| a.  Aus $pm$ | | | | | |
| 99 | 29 | 1 | | 36 | 165 |
| 129 (=78,1%) | | | | (=21,9%) | |
| b.  Aus $PM$ | | | | | |
| 122 | 116 | | 18 | | 256 |
| 256 (=100%) | | | | | |
| c.  Aus $W$ | | | | | |
| 23 | 11 | 19 | 2 | 48 | 103 |
| 55 (=53,4%) | | | | (=46,6%) | |
| d.  Aus $w$ | | | | | |
| | | | | 46(=100%) | |

(pm, PM, W und w wie zuvor,
gfp=ganzfarbigpurpurn)

(1)  Jour. Coll. Agric., Imp. Univ. Tokyo 8, 1921, 93–133.
(2)  Vgl. Nr. 2 in Tab. II. A, b, S. 209.

B, b, 122 und 116);[1] weiss ist dabei niemals ausgegeben. Wenn man die Tabelle III (A–B) genauer ansieht, kann man erkennen, 1. dass die Mosaiknachkommen aus schwachpurpurnen Eltern grösstenteils schwachpurpurn sind ($\frac{99}{129}$ oder ungefähr 80%, vgl. Tab. III. B, a) und 2. dass weit mehr starkpurpurne Nachkommen hervorgehen aus stark- als aus schwachpurpurnen Eltern (im ersteren Falle $\frac{116}{256}$ oder 45,3% starkfarbig, im zweiten $\frac{29}{129}$ oder 22,4%, vgl. Tab. III, b und a).

2. Weissartig ist als ein extremer Fall der Mosaikpflanzen aufzu-fassen, wobei die purpurnen Streifen und Flecken nur minimal vorhan-den sind. In der Tabelle III. B, c haben wir das Gesammtresultat seiner Selbstbefruchtung aus 6 Individuen angegeben, während in der Tabelle III. A, c (S. 210) dasselbe aus jedem besonders gezeigt wird. Ein Überblick der letzteren lehrt uns, dass das Selbstungsresultat nicht immer dasselbe ist: z.B. bei 1. findet man unter den Nachkommen beiderlei Arten von Mosaikpflanzen, doch bei 3. und 6. vermisst man sie gänzlich. Indem es ausser den Mosaikpflanzen weiss herausspalten kann, wie man in der Tabelle III, c sehen kann, kann es unter der schwachpurpurnen Klasse eingereiht werden.

3. Weiss aus 1922 ist homozygot und folglich hat es 1923 nur seinesgleichen ausgegeben (Tab. III, A-B, d). In Tab. II. B, c haben wir gesehen, dass weiss zu 1 weiss und 3 weissartig aufgespalten ist. Ich glaube, dass höchstwahrscheinlich es kein wirkliches weiss ist, sondern es ist nur weissartig, wobei die purpurnen Streifen und Flecken so un-ansehnlich sind, dass sie übersehen werden können, Kryptomosaik im Sinne CHITTENDENs.[2]

4. Unter den starkpurpurnen Mosaikpflanzen aus dem J. 1922 wurden ausser einem Exemplar, wobei die eine Hälfte der Krone mosaikartig und die andere ganzfarbigpurpurn gefärbt war (Nr. 1) noch zwei andere gefunden, wobei in je einem Kronenblatte ein fast ein Drittel ihrer ganzen Breite einnehmender purpurner Band nachzuweisen war (Nr. 2 und 3). Die Selbstbefruchtung dieser dreierlei Individuen gab die Resultate wie in Tab. IV.

TABELLE IV (1923)

|       | pm | PM | gfp | Summe |
|-------|-----|-----|-----|-------|
| Nr. 1 | 11  | 7   | 2   | 20    |
| Nr. 2 | 27  | 8   | 2   | 46    |
| Nr. 3 | 5   | 8   | 2   | 15    |

(1) Ganzfarbig wird als ein extremer Fall von starkfarbig betrachtet und folg-lich unter *PM* eingerechnet.
(2) Bibliographia Genetica **3**, 1927, 356–442.

Aus dem obigen kann man wohl schliessen, dass die Mosaikpflanzen mit teilweise ganzfarbigen Kronen sich völlig in derselben Weise verhalten wie die gewöhnlichen starkpurpurnen Mosaikpflanzen und deshalb als eine Varietät derselben unter der Klasse der letzteren eingereiht werden können.

5. Noch ein anderer Versuch betrifft die Selbstbefruchtung einiger ganzfarbigpurpurnen Blüten. Oben haben wir erwähnt, dass einige starkpurpurne Mosaikpflanzen einzelne rote Äste produziert haben, welche ganzfarbigpurpurne Blüten tragen (S. 194). Die Resultate der Selbstbefruchtung solcher Blüten waren wie in Tab. V.

TABELLE V (1923–1924)

| | | pm | PM | gfp | Summe |
|---|---|---|---|---|---|
| Individuum I { | Blüte Nr. 1 | 1 | 3 | 1 | 5 |
| | „  „  2 | | 2 | | 2 |
| „  II | „  „  3 | 3 | 4 | 1 | 8 |
| Summe | | 4 | 9 | 2 | 15 |

Indem nicht nur jede Blüte von *Portulaca* im allgemeinen wenige keimfähige Samen produziert, sondern auch weil viele Keimlinge gewöhnlich sehr früh absterben, ist die Zahl der aus jeder Blüte zur Untersuchung der Blütenfarbe erhaltenen Nachkommen sehr beschränkt, doch aus den oben genannten Versuchsresultaten kann man wohl sehen, dass die an roten Ästen produzierten ganzfarbigpurpurnen Blüten genetisch als starkpurpurne Mosaikblüten, sozusagen als eine Varietät derselben, zu betrachten sind; denn die ausgegebene Nachkommenschaft ist bei beiden ganz dieselbe.

6. Auf Tab. III wurde die Entstehung einer gewissen Anzahl von Pflanzen mit ganzfarbigpurpurnen Blüten aus selbstbefruchteten starkpurpurnen Mosaikpflanzen erwähnt. Durch Selbstbefruchtung wurde daraus[1] viele Samen bekommen und sie wurden gesät, doch leider sind nur sehr wenige zur Keimung gekommen, und zwar aus einem einzigen Individuum, welches 7 ganzfarbigpurpurne Pflanzen und 1 schwachpurpurne Mosaikpflanze betrugen. Somit ist das untersuchte ganzfarbigpurpurne Individuum heterozygot. Jedoch scheint es mir nicht unwahrscheinlich zu sein, dass die weiteren Versuche an diesen ganzfarbigen Nachkommen schliesslich zur Entstehung der ganzfarbigpurpurnen Homozygoten führen mögen.

7. Wir haben oben gesehen, dass die selbstbefruchteten schwach-

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(1) Aus Tab. III. A, b, Nr. 6, mit * markiert, S. 210.

purpurnen Mosaikpflanzen stets die Aufspaltung erfahren, somit sind sie immer heterozygot.    Nun kann man zunächst fragen: Sind sie die Heterozygoten im MENDELschen Sinne? Oder anders ausgedrückt, kann bei unseren Mosaikpflanzen das MENDELsche Gesetz gelten? Wir haben oben gesehen, dass aus den selbstbefruchteten schwachpurpurnen Mosaikpflanzen stets eine gewisse Anzahl von weissen Nachkommen herausgespalten ist, und zwar nach den folgenden Zahlenverhältnissen:

| Mosaikpflanzen | weiss |
|---|---|
| 78% | 22% (aus Tab. I) |
| 90% | 10% (aus Tab. II) |
| 78,1% | 21,9% (aus Tab. III) |
| Mittel  82,0% | 38,0% |

Im ersten und dritten der oben angeführten Fällen nähert sich das Zahlenverhältnis von Mosaik- und weissen Pflanzen etwa 3:1, doch im zweiten ist es ganz anders.    Wenn trotzdem diese zwei obige Fälle für eine monohybride MENDELsche Aufspaltung gehalten werden sollten, dann müssten z.B. aus den selbstbefruchteten schwachpurpurnen Eltern dreierlei Arten von Nachkommen im Verhältnis starkpurpurn : schwachpurpurn : weiss=1:2:1 herausgespalten werden.    Dies trifft hier gar nicht zu, denn wir haben starkpurpurn : schwachpurpurn : weiss=5:92:47=0,14:2,56:1,30 (pro 4).    Aus alldem ist es ganz klar, dass wir bei der Vererbung unserer Mosaikpflanzen mit MENDELschem Gesetz nicht zu tun haben.

8.    Nach den Untersuchungen von CORRENS über die *striata*-Sippe von *Mirabilis Jalapa*[1] gibt die letztere ausser ihresgleichen noch zweierlei andere Arten von Nachkommen, *rosea* und *gilva*.    Die *striata*-Nachkommen sind immer aufspaltbar, doch sind die *gilva* immer und die *rosea* teilweise rein.    Daraus sieht man, dass bei dem soeben erwähnten Fall zweierlei Arten reiner Gameten, *gilva* und *rosea* und eine unreine, sog. Mosaikgamete, ausgeschieden werden.    Bei den „patched" Pflanzen von *Lathyrus odoratus* sehen wir nach PUNNETT[2] das gleiche Verhalten, da auch hier zweierlei Arten reiner Gameten, rot und purpurn, und eine unreine, Mosaikgamete, vorkommen.    Vergleicht man nun unseren Fall mit den zwei oben besprochenen, so ist es klar, dass bei uns eine reine Gametart produziert wird, nämlich weisse; auch ist die Produktion einer reinpurpurnen am wenigsten wahrscheinlich.    Betreffend die Mosaikpflanzen kann man auch hier

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(1)    Ber. Deutsch. Bot. Ges. **28**, 1910, 418 ff; auch Gesammelte Abhdlg. 1924, 657 ff.
(2)    Jour. Genetics **12**, 1922, 255.

wohl, wie bei den obengenannten Fällen von *Mirabilis* und *Lathyrus*, die Ausbildung der Mosaikgameten annehmen.

Soweit die Zusammenfassung der bei der Selbstbefruchtung der Mosaikpflanzen erzielten Resultate.

Nun wenden wir nun zur Deutung der bekommenen Resultate zu!

Bei den Mosaikpflanzen von *Portulaca* gibt es, wie schon oben erläutert, zweierlei scharf unterscheidbare Arten, schwach- und starkfarbig. Der Unterschied zwischen beiden ist erblich und es handelt sich keineswegs um blosse Fluktuation. Ausserdem wurde es festgestellt, dass durch Selbstbefruchtung starkpurpurn ausser seinesgleichen noch stets schwachpurpurn gibt und umgekehrt. Wie kann man das ganze Phänomen deuten?

Ehe ich weiter gehe, möchte ich zunächst die EYSTERsche Untersuchungen[1] über die hochvariable Perikarpfarbe der Maisähren und seine für die Erklärung des von ihm beobachteten eigentümlichen Verhaltens aufgestellte Hypothese kurz erwähnen, insofern als sie auch für die Erklärung unseres Falles brauchbar zu sein scheint, und zwar in etwas modifizierter Form. Das Perikarp der von diesem amerikanischen Forscher untersuchten Maisähren ist gewöhnlich orangefarbig. Nach ihm ist diese Farbe sehr unbeständig, denn nicht nur ist sie in ihrer Intensität höchst variabel, sondern sie kann in extremen Fällen weiss oder rot (kirschrot) sein. Beachtenswert ist ferner die Tatsache, dass nicht selten die orange Farbe in rot und weiss zerlegt und damit das Perikarp mosaikartig rot und weiss gefärbt wird; dabei ist es zu bemerken, dass die aus schwach- und starkorangefarbigen Ähren herrührenden Abkömmlinge vorwiegend schwach- bzw. starkmosaikfarbig sind, d.h. dass die Farbenintensität erblich ist. Zur Erklärung des hier kurz geschilderten eigentümlichen Verhaltens der Maisähren schlägt EYSTER eine Hypothese vor, wonach das Gen für die orange Farbe ein hochkompliziertes Gebilde ist, welches unter anderen zweierlei Arten von Elementen entgegengesetzter Eigenschaft enthält, d. h. das den roten Farbstoff bildenden und das ihn nicht bildenden und die Farbenverhältnisse des Perikarps werden nach deren relativer Menge bestimmt. Auch kann das Gen für die orange Farbe bisweilen zu zweierlei Genenelementen zerlegt werden, und zwar im somatischen Gewebe durch irgend einen mitotischen Vorgang derart, dass das eine alle zur Farbstoffbildung beizutragenden Genenelemente und das andere alle ihn nicht bildenden erhalten werden. Die soeben be-

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[1]  Genetics **9**, 1924, 372 ff.

sprochene Zerlegung eines Genes zu zweierlei Elementen vom entgegengesetzter Charakter wird sowohl die Mosaikbildung als die Entstehung von reinen weissen und roten Abkömmlingen erklären. Weiter, indem die Farbenintensität von der relativen Menge von zweierlei Arten von Genenelementen abhängig ist, ist die oben erwähnte Erblichkeit der Farbenintensität des Mosaiks gut verständlich. Soweit die EYSTERsche Untersuchung und seine Hypothese.

Kehren wir jetzt zu unserem Falle zurück, so haben wir in der Regel mit der Mosaikfarbe zu tun und wir brauchen deshalb nicht die Annahme zu machen, dass ein Gen in zweierlei Genenelementen im somatischen Gewebe zerlegt werden, sondern wir haben anzunehmen, dass es von Anfang an zwei getrennte Genen existierten, das den purpurnen Farbstoff bildende (Farbengen) und das ihn nicht bildende (Weiss-Gen). Wir müssen dabei die Annahme machen, dass beiderlei Arten von Genen in jeder Zygote oder in jeder Gamete jedesmal in einer mehr oder minder grossen Anzahl vertreten waren, um damit eine sog. kumulative Polymerie im Sinne JOHANNSENS[1] auszumachen, d.h. je zahlreicher die gleichsinnigen Gene jeglicher Art sind, desto stärker ist das dadurch bedingte Reaktion.[2] Der Mosaikgrad wird dann durch die relative Menge dieser zweierlei Genenarten bestimmt, welche in ihrem Vermögen gegenüber der Farbstoffbildung gerade entgegengesetzt sind. In anderen Worten kann der in Rede stehende Mosaikgrad der Blüten als das Effekt ihrer Kombinationswirkung oder vielmehr der Konkurrenz zwischen beiden erfasst werden. Übertrifft die Zahl der Farbengene die anderen wesentlich, so werden wir das starkpurpurne Mosaik und im entgegengesetzten Falle das schwachpurpurne vor uns haben, natürlich unter der Voraussetzung, dass das Vermögen jedes Genes gegenüber der Farbstoffbildung ganz gleich ist. Bei der Entstehung der Nachkommenschaft aus denselben wird wie gewöhnlich die Umbildung der Genenkombination stattfinden und dabei kann man aus naheliegenden Gründen ausser solchen Nachkommen, wobei das Zahlenverhältnis der darin enthaltenen zweierlei Gene dasselbe bleibt wie bei den Eltern, noch denjenigen begegnen, die etwaige Abweichung aufweist. In der Tat sind bei schwachfarbigen,

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(1) Elemente der exakten Erblichkeitslehre, 3. Aufl. 1926, 489.

(2) Im Falle, wenn man mit Weiss-Genen allein zu tun hat, ist natürlich das kumulative Effekt derselben phänotypisch unsichtbar, denn die dadurch verursachte weisse Farbe ist ganz einerlei, ob sie dem einzigen Gen oder mehreren Genen zu verdanken ist. Im Falle der Kombinationswirkung von Weiss- und Farbengenen wird jedoch das kumulative Effekt der ersteren äusserlich manifestiert werden, indem je grösser die Zahl von Weiss-Genen ist, umso schwächer wird der Farbenanteil des Mosaiks sein.

wo die Weiss-Gene an Zahl die Farbengene wesentlich übertreffen, die Mehrzahl der Abkömmlinge ebenfalls schwachfarbig wie bei den Eltern ; doch erweist sich eine geringe Anzahl derselben als starkfarbig, d.h. die Zahl der Farbengene ist dabei viel grösser als die von weissen. Im übrigen scheint bei schwachfarbigen die Zahl von Weiss-Genen so erheblich grösser zu sein als die von Farbengenen, dass eine Gruppe der ersteren sich von den letzteren lostrennen kann, woraus dann wenige reinweisse Abkömmlinge entstehen. Bei den starkpurpurnen Mosaikpflanzen, wo die Nachkommenschaft aus beiderlei Arten von Mosaikpflanzen derart zusammengesetzt ist, dass die starkpurpurnen Nachkommen prozentisch weit zahlreicher herausgespalten sind als im Falle der schwachpurpurnen Eltern und wo die Zahlenverhältnisse von zweierlei Genenarten gerade umgekehrt ist, wie bei den schwachpurpurnen, kann man das ganze in fast analoger Weise erklären. Bei den starkpurpurnen Mosaikpflanzen scheinen übrigens die Zahl der Farbengene die weissen soweit zu übertreffen, dass eine Anzahl derselben selbständig werden und die Ausbildung von wenigen ganzfarbigpurpurnen Pflanzen veranlassen kann ; dagegen scheint die Zahl von Weiss-Genen nicht gross genug zu sein, um weisse Pflanzen zu produzieren.

Noch muss das folgende hier hinzugefügt werden. Vergleicht man unseren Fall mit dem oben zitierten EYSTERschen, so bemerkt man zwischen beiden einen kleinen Unterschied. Bei dem letzteren sind sowohl die Farbenintensität als der Mosaikgrad des Perikarps höchst verschieden, denn dabei kann man nicht nur die möglichst denkbarstenen Übergange von weiss bis tiefkirschrot beobachten, sondern auch eine Reihe verschiedener Typen des Mosaiks. In unserem Fall dagegen, sind sowohl die Farbenintensität als auch der Mosaikgrad weit einheitlicher als bei jenen, doch mangelt es keineswegs an Übergangsstufen. So haben wir z. B. weiss, weissartig, schwachpurpurnes Mosaik, starkpurpurnes Mosaik, vorwiegend purpurnes Mosaik mit einigen teilweise oder ganz purpurnen Kronenblättern, ganzfarbigpurpurn, von denen jedes auch unter sich kleine Fluktuationen aufweist. Dass alle solche Farbenunterschiede den Mengenverhältnissen von beiderlei in Konkurrenz getretenen Genen zu verdanken sind, wird kaum besonderer Erwähnung bedürfen.

# Kreuzung

Verschiedene Kreuzungen wurden an Mosaikpflanzen ausgeführt, unter denen hier bloss die Versuchsresultate der Kreuzung einer schwachpurpurnen Mosaikpflanze ♀ mit einer weissen ♂ etwas eingehender geschildert werden soll. Wie es in meinen Abhandlungen 1921 und 1924[1] erwähnt wurde, gibt es bei *Portulaca grandiflora* vielerlei Arten von weissen Sippen, welche phänotypisch gleich und doch genotypisch nicht einheitlich sind, wie z.B. $ccP_sP_s$, ccRRBB usw.; die bei der in Rede stehenden Kreuzung gebrauchte weisse Sippe ist diejenige, welche in bezug auf die Färbung gar keine dominante Gene enthält, d.h. einfach durch cc bezeichnet werden kann und vermittelst der jahrelang ausgeübten Selbstbefruchtungsversuche als homozygot bewiesen worden ist. Die Kreuzung *pm* ♀ × cc ♂ wurde 1921 ausgeführt und die Samen wurden an drei Pflanzen geerntet. Die daraus hervorgegangenen $F_1$-Pflanzen betrugen 7, 2 bzw. 14, somit insgesamt 23. Rücksichtlich der Blütenfarbe waren sie merkwürdigerweise nicht einheitlich: grösstenteils waren sie weiss, wie bei der Vaterpflanze (Nr. I), doch waren wenige schwachpurpurn mosaikartig, wie bei der Mutterpflanze (Nr. II), während bei noch wenigen anderen die weissen Kronenblätter mit einzelnen sehr schwachen und daher unansehnlichen orangefarbigen Flecken versehen waren, welche im Herbst viel intensiver und deutlicher werden (Nr. III). Somit ist das oben erwähnte Verhalten von dem, was wir gewöhnlich bei den MENDELschen Bastarden sehen, total verschieden.

Diese dreierlei Arten von Nachkommen wurden an ihren weiteren Generationen untersucht.

### a. $F_1$-Pflanze Nr. I

Die Resultate der Selbstbefruchtung der weissen $F_1$-Pflanzen (Nr. I) sind eingehend in Tab. VI. A (S. 211) hervorgehoben und unten in Tab. VI. B kurz zusammengefasst.

Man sieht $F_1$-weiss zu weiss und weissartig aufgespalten; im übrigen ist dabei eine Pflanze mit orangefarbigen Blüten (=*gpo*) entstanden.

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[1] 1. c., auch Zeit. ind. Abst. u. Ver.lehre **26**, 1922, 122 ff. und Japan. Jour. Bot. **2**, 1924, 45 ff.

Die in Tab. VI. A-B angegebenen Resultate erinnern an grosses Reichtum der $F_1$-Pflanzen an den den Farbstoff nicht bildenden (=Weiss-) Genen. Wie oben mehrmals erörtert, ist jede schwachpurpurne Mosaikpflanze von vornherein durch den Besitz von relativ vielen Weiss-Genen ausgezeichnet. Bei unserem Versuche wurde sie mit einer weissen Pflanze cc gekreuzt, welche ausschliesslich Weiss-Gene enthält, daher kein Wunder, dass die $F_1$-Pflanzen auch daran sehr reich sind. Dabei ist es zu erwarten, dass eine gewisse Anzahl von Weiss-Genen sich aus dem Verbande loslösen und zu einer selbständigen Gruppe vereinen, um die Zygoten mit auszubilden, worin diese Gruppe hineingeführt wird, d.h. weisse Homozygoten. In der Tat hat die Nachprüfung der aus $F_2$ produzierten weissen Nachkommen auf ihre genotypische Natur vermittelst der bis zu $F_3$ und $F_4$ ausgedehnten Versuche unzweideutig gezeigt, dass sie sich immer als konstant erweisen (vgl. Tab. VII, S. 211). Die Tatsache, dass die $F_2$-Abkömmlinge vornehmlich aus weiss und weissartig bestehen, dürfte aus dem oben gesagten leicht verständlich sein ; hinzuzufügen ist, dass weissartig als ein extremer Fall der schwachfarbigen Mosaikpflanze aufzufassen ist, wobei die Menge von Farbengenen minimal ist. Es ist von reinweissem dadurch unterschieden, dass es an den Kronenblättern einige winzige purpurne Flecken oder Streifen zeigt. Dass trotz diesen geringfügigen Unterschiede beide genotypish doch total verschieden sein müssen, erhellt sich aus folgenden Versuchen : jeder von ihnen wurde mit einer orangefarbigen Pflanze CC gekreuzt und die Resultate in der nächsten Generation waren wie in Tab. VIII.

Oben haben wir gesehen, das unter den Nachkommen aus der $F_1$-Pflanze Nr. I ein orangefarbiges Individuum neuentstanden ist. Die Selbstbefruchtung desselben hat uns gezeigt, dass es eine Heterozygote ist, denn es hat sich zu 26 orange : 10 weiss, d. h ungefähr zu 3:1

TABELLE VI. B (1922)

Selbstbefruchtung von $F_1$ Nr. I (= $F_2$)

| $w$ | $W$ | $gfo$ | Summe |
|---|---|---|---|
| 337 | 61 | 1 | 399 |
| % 84,5 | 15,3 | 0,2 | |

$gfo$=ganzfarbigorange

TABELLE VIII. B (1923)

| Kreuzung | Nachkommen | | |
|---|---|---|---|
| | orange | purpurn | Summe |
| weiss cc ♀ × orange CC ♂ | 96 | 0 | 96 |
| weissartig × orange CC ♂ | 37 | 21 | 58 |

aufgespalten.    Hier dürften wir mit einer MENDELschen Aufspaltung zu tun haben, was sehr beachtenswert ist, wenn man die Tatsache in Betracht zieht, dass die ursprünglichen Mosaikpflanzen sich nicht mendelistisch verhalten.    In bezug auf die Frage, wie dieses orange-farbige Individuum entstanden ist, kann man an vielerlei Möglichkeiten denken, und die am meisten naheliegende Annahme ist, dass bei weiss cc, welches in diesem Falle reichlich vertreten ist, eine Mutation c→C eingetreten ist, um ein heterozygotes orange Cc zu produzieren.[1]

## b.    F$_1$-Pflanze Nr. II

Die F$_1$-Pflanzen aus *pm*♀ × *w*♂ stellen teilweise die purpurnen Mosaikpflanzen dar, wie bei der Mutterpflanze.    Die durch Selbstbe-fruchtung derselben erzeugten Nachkommen sind in F$_2$ zu schwachpur-purnen Mosaikpflanzen und weiss aufgespalten, doch ausser denselben ist noch eine kleine Anzahl von schwachfarbigorange Mosaikpflanzen (unten als *om* bezeichnet) entstanden (s. Tab. IX).

In bezug auf die Tabelle IX möchte ich einiges über die Entste-hung der orangefarbigen Mosaikpflanzen bemerken.    Die Mechanik, wodurch sie zur Ausbildung angekom-men sind, ist unbekannt.    Es möge dafür vielerlei denkbaren Möglichkeiten geben. Z.B.    kann man es als nicht un-wahrscheinlich betrachten, dass das sich auf die orange Farbe (entweder ganzfarbig oder Mosaik) beziehende Gen, welches bisher von den anderen Genen überdeckt worden war,[2] jetzt durch irgend einen Vorgang frei gemacht worden sei und plötzlich zum Vorschein kam.    Auch eine andere Alternative wäre nicht aus-zuschliessen.    Das Gen ist natürlich ein hochkompliziertes, zusammen-gesetztes Gebilde und demnach ist es zu erwarten, dass es bisweilen eine Zerlegung in seinen Bestandteilen erfährt wie es gerade EYSTER bezüglich des Gens für die orange Perikarpfarbe der Maisähren daran hingewiesen hat.[3]    Es wäre deshalb nicht unmöglich auzunehmen, dass gewisse bisher in der dem purpurnen Mosaik zu Grunde liegenden

TABELLE IX. B (1922)

Selbstbefruchtung der
F$_1$-Pflanze Nr. II (=F$_2$)

| *pm* | *om* | *w* | Summe |
|------|------|-----|-------|
| 92 | 14 | 33 | 139 |
| % 66,1 | 13,2 | 23,7 | |

---

(1)    Für die andere Erklärungsweise s. sogleich unten.
(2)    Diese Tatsache ist leicht vorstellbar, indem, wie schon bei *Portulaca* und vielen anderen Pflanzen bewiesen worden ist, purpurn auf orange epistatisch wirkt.
(3)    l. c.

Gene enthaltenen Bestandteile sich aus dem Verbande ablösten, um selbständig das orangefarbige Mosaik hervorzurufen.[1]

Unten werden bloss die Resultate von weiteren Versuchen an den in Tab. IX angegebenen purpurnen und weissen Nachkommen kurz geschildert, insofern als das Verhalten der orange Mosaikpflanzen ausführlich bei der $F_1$-Pflanze Nr. III beschrieben werden wird. Die in Rede stehenden Resultate stehen wie in Tab. X.

Wie es in der Tabelle X gezeigt wird, haben in $F_3$ die schwach-purpurnen Mosaik-Nachkommen aus $F_2$ ausser ihresgleichen und einer Anzahl von schwachorange Mosaikpflanzen und weissen, wie es bei $F_2$-Generation der Fall war, noch wenige starkpurpurne Mosaikpflanzen produziert. Ausserdem ist ein rot neuentstanden, deren Entstehungsweise unbekannt ist, wenn man auch dafür einige Möglichkeiten vorbringen könnte, wie es oben (S. 201) schon bei orange erläutert wurde. Weiss hat sich als konstant erwiesen.

TABELLE X. B (1923)

| $pm$ | $PM$ | $om$ | $w$ | rot | Summe |
|------|------|------|------|------|------|
| Aus $pm$ | | | | | |
| 78 | 17 | 35 | 30 | 1 | 161 |
| % 48,5 | 10,6 | 21,7 | 18,6 | 0,6 | |
| Aus $w$ | | | | | |
| | | | 132 (=100%) | | |

## c. $F_1$-Pflanze Nr. III

Die $F_1$-Pflanze Nr. III ist im Grunde weiss und es lassen sich darüber wenige äusserst schwache orange Flecken erkennen, welche im Herbst viel intensiver und ansehnlicher werden, dass sie als sehr schwach orangefarbige Mosaikpflanzen angesehen werden. Ihre Aufspaltung in $F_2$ hat stattgefunden, wie es in Tab. XI gezeigt wird.

Daher haben alle $F_1$-Pflanzen sich als heterozygot erwiesen.

TABELLE XI. B (1922)

| $om$ | $w$ | Summe |
|------|------|------|
| 91 | 17 | 108 |
| % 84,3 | 15,7 | |

Die weiteren Untersuchungen im nächsten Jahre haben die Resultate ergeben, wie man in Tab. XII sieht.

---

(1) Für die S. 201 geschilderte Entstehung von heterozygotem orange wäre die gleichartige Möglichkeit nicht ausgeschlossen. Ob welche Alternative hier zutreffen wird, ist jetzt kaum zu entscheiden.

Somit hat *om* sich wieder als heterozygot erwiesen.   Zugleich sieht man, dass aus *w* wenige *om*-Individuen herausgespalten sind.   Wenn man Tabelle XII, A, b (S. 214) genauer ansieht, kann man kennen lernen, dass *om* bloss gelegentlich herausgespalten ist.   Die Produktion von *om* in diesen einzelnen Fällen ist vielleicht einem auch an vielen anderen Fällen beobachteten sog. Rückmutation zuzuschreiben und *w* ist als eine rezessive Homozygote anzusehen.

TABELLE XII. B (1923)

| *om* | *w* | Summe |
|---|---|---|
| Aus *om*[1] | | |
| 108 | 42 | 152 |
| % 71,1 | 28,9 | |
| Aus *w* | | |
| 4 | 100 | 104 |
| % 3,9 | 96,1 | |

Bisher sind keine Unterscheidung zwischen der Farbenintensität der orange Mosaikpflanzen gemacht, aber von 1924 an wurden immer zweierlei Arten von orange Mosaikpflanzen, schwach- bzw. starkfarbigen, besonders behandelt.  Die aus dem Versuche i. J. 1923 hervorgegangenen *om*-Nachkommen haben sich nämlich 1924 wie in Tab. XIII verhalten.

TABELLE XIII. B (1924)

| *om* | *OM* | *w* | Summe |
|---|---|---|---|
| 41 | 18 | 9 | 68 |
| % 60,0 | 26,5 | 13,5 | |

*OM*=starkorange Mosaikpflanze

Somit haben wir bei in der Tabelle XIII angedeuteten Versuche die Herausspaltung von starkorange Mosaikpflanzen aus schwachorange nachgewiesen.

Das Verhalten dieser zweierlei Nachkommen in der nächsten Generation steht wie in Tab. XIV.

TABELLE XIV. B

| *OM* | *om* | *gfo* | rot | Summe |
|---|---|---|---|---|
| Aus *OM* | | | | |
| 156 | 138 | 15 | 3 | 312 |
| % 50,0 | 44,3 | 4,8 | 0,9 | |
| Aus *om* | | | | |
| 6 | 98 | | | 104 |
| % 5,8 | 94,2 | | | |

Vergleicht man die obigen Resultate mit denen der Selbstbefruchtung der schwach- bzw. starkpurpurnen Mosaikpflanzen (vgl. Tab. II-III, S. 191, 192, 209, 210), so bemerkt man die folgenden Übereinstimmungen und Unterschiede.

a.  Die Nachkommenschaft aus schwachorange besteht vornehmlich aus seinesgleichen (z. B. in Tab. XIII. B *om:om+OM*=41:41 +18=72,5% und in Tab. XIV. B *om:om+OM*=98:98+6=94,2%).

(1)  Bei Nr. 2 in Tab. XII. A, a ist das Zahlenverhältnis von *om*- und *w*-Nachkommen gerade umgekehrt, wie bei den andern Nrn.  Ob es irgend einem Fehler zuzuschreiben ist, bleibt noch unentschieden.

b.   Die Nachkommenschaft aus starkorange besteht aus ungefähr gleichen Teilen von beiderlei Arten (in Tab. XIV.B $OM:om=156:138$ $=53\%:47\%$). Die Zahl einer Art kann entweder ein wenig grösser oder kleiner als die der andern sein (vgl. Tab. XIV.B und XV.B).

c.   In der Nachkommenschaft aus schwachorange ist weiss entweder enthalten, wie im Falle der schwachpurpurnen Mosaikpflanzen oder nicht (vgl. Tab. XIII und XIV). Das heraussgespaltene weiss ist homozygot.

d.   Das gleiche beobachtet man auch bei der Nachkommenschaft aus starkorange. Z.B. in Tab. XIV.B befinden sich gar keine weisse Nachkommen, aber solch ein Verhalten ist keineswegs allgemein, denn man kann bisweilen sie nachweisen, wie das Beispiel in Tab. XV zeigt.

TABELLE XV. B

Aus $OM$

| $OM$ | $om$ | $w$ | Summe |
|------|------|------|-------|
| 32 | 35 | 20 | 87 |
| % 36,8 | 40,2 | 23,0 | |

Wie man aus mancherlei oben zitierten Beispielen ersehen kann, ist die orange Mosaikpflanze, entweder stark- oder schwachfarbig, immer als heterozygot bewiesen, denn sie spaltet stets die andere Art Mosaikpflanze und nicht selten zugleich auch weiss heraus. Daher stimmt ihr Verhalten wesentlich mit demselben der purpurnen Mosaikpflanze überein und kann ebenso wohl erklärt werden durch die Annahme der Konkurrenzwirkung von zweierlei Arten von Genen, den orange Farbstoff bildenden und ihn nicht bildenden. Ob dabei weiss gebildet ist oder nicht, ist eine Nebensache, welche keineswegs uns an dieser Annahme hindert.

e.   Die Entstehung von orange und rot, wie in Tab. XIV erwähnt, ist als ein zufälliger, keineswegs normaler Vorgang anzusehen, wie ebenfalls z.B. die von ganzfarbigpurpurnen aus den purpurnen Mosaikpflanzen (vgl. Tab. III. B), so z.B. findet man in Tab. XVII gar keine solche Abkömmlinge.

TABELLE XVI (1925)

| $OM$ | $om$ | orange | Summe |
|------|------|--------|-------|
| 12 | 18 | 6 | 56 |
| % 33,3 | 50,0 | 16,7 | |

f.   Bei orange Mosaikpflanzen weist man ausser den oben erwähnten noch einige bei den purpurnen beobachteten analogen Phänomene nach. Um ein Beispiel davon hervorzuheben, habe ich bei einem schwachorangen Individuum einen Ast mit ganzfarbigorange Blüten beobachtet (in Tab. XIII. A, S. 214 unter den mit * angedeuteten Nachkommen). Das Resultat der Selbstbefruchtung solcher

Blüten steht wie in Tab. XVI.  Woraus man wohl schliessen kann, dass die in Rede stehenden ganzfarbigorange Blüten genotypisch als Mosaikblüten zu betrachten sind, ebenso wie in Tab. IV (S. 193) hervorgehobene ganzfarbigpurpurnen.  Den soeben geschilderten Resultaten nach stehen diese orange Blüten näher den stark- als den schwachfarbigen, denn beiderlei Arten von Nachkommen sind in fast gleicher Zahl vertreten.  Somit kann man daran denken, dass wir hier mit einer Knospenvariation zu tun haben, wodurch starkfarbig aus schwachfarbig hervorgegangen ist.

## Andere Kreuzungen

Anhangsweise sei unten die Resultate einiger anderen Kreuzungen kurz geschildert.

1.  Weiss (=cc) ♀ × *PM* ♂.—Unter den in meinen 1921 und 1924 publizierten Abhandlungen[1] hervorgehobenen weissen Sippen wurde bei dieser Kreuzung diejenige, welche keine sich auf die Färbung beziehende dominante Gene enthält (=cc) ins Gebrauch genommen.  In $F_1$ sehen wir schon eine Aufspaltung, wie in Tab. XVII.  Es ist bemerkenswert, dass keine *PM*-Individuen, d.h. keine dem einen der Elter ganz ähnliche Nachkommen herausgespalten sind, was auf die Armut an den Farbengenen hinweisen dürfte.  Dabei ist es auch beachtenswert, dass eine grosse Anzahl von orange Mosaikpflanzen (=ungefähr 45%) ausgegeben ist.

TABELLE XVII. B

| pm | om | w | Summe |
|---|---|---|---|
| 38 | 35 | 5 | 78 |
| % 48,7 | 44,9 | 0,65 | |

2.  *PM* ♀ × weiss (=ccRRBB) ♂.—Weiss, welches in dieser Kreuzung benutzt wurde, ist dasjenige, welches zwei sich auf die Färbung beziehende dominante Gene R und B enthält und welches, gekreuzt mit orange (=CC) purpurn geben wird.[2]  Entsprechend der genotypischen Natur des benutzten weiss sind die bekommenen Resultate von den in Tab. XVII erläuterten etwas verschieden (s. Tab. XVIII).

TABELLE XVIII. B

| pm | PM | gfp | Summe |
|---|---|---|---|
| 63 | 32 | 14 | 109 |
| % 57,8 | 29,4 | 12,8 | |

Wie aus der Tabelle XVIII sehen kann, sind dabei *pm*, *PM* und

----

(1) 1. c.
(2) Vgl. IKENO, Jour. Coll. Agric., Imp. Univ. Tokyo **8**, 1921, 108 und Zeit. ind. Abst. u. Ver.lehre **29**, 1922, 130.

*gfp* herausgespalten, doch sind keinerlei weisse Pflanzen hervorgekommen, was auf die Armut an den weissen Genen hinweist und im Gegensatz zu dem in Tab. XVII angegebenen Falle steht. Es mangelt sich völlig an den orange Nachkommen.

TABELLE XIX. B

| *gfp* | *gfo* | *pm* | *PM* | *om* | Summe |
|---|---|---|---|---|---|
| 56 | 15 | 10 | 11 | 1 | 93 |
| % 60,2 | 16,1 | 10,8 | 11,8 | 1,1 | |

3. *PM* ♀ × orange (= CC) ♂.—Die F₁-Pflanze ist ganzfarbigpurpurn und in F₂ weist man die in Tab. XIX gezeigte Aufspaltung nach, welche ziemlich kompliziert ist.

TABELLE XX. B

| *pm* | *PM* | *gfp* | Summe |
|---|---|---|---|
| 10 | 22 | 171 | 203 |
| % 5,0 | 10,8 | 84,2 | |

4. *PM* ♀ × purpurn (= CCRRBB ♂).—F₁ ist ähnlich dem Vater, d.h. ganzfarbigpurpurn. In F₂ haben wir die Resultate wie in Tab. XX. Entsprechend der genotypischen Natur der Vaterpflanze bekommt man eine grosse Anzahl von ganzfarbigpurpurnen Nachkommen.

TABELLE XXI. B

| *om* | *gfo* | *gfp* | *w* | Summe |
|---|---|---|---|---|
| 223 | 11 | 2 | 4 | 240 |
| % 92,9 | 4,5 | 0,9 | 1,7 | |

5. Weiss (= cc) ♀ × *om* ♂.—Diese Kreuzung gab schon in F₁ die Aufspaltung wie in Tab. XXI, was natürlich durch die heterozygote Natur von *om* bedingt wird. D. h. die F₁-Nachkommenschaft besteht vornehmlich aus den der Mutterpflanze ähnlichen Individuen und einer geringen Anzahl der andersartigen.

## Zusammenfassung

1. Bei den purpurnen Mosaikpflanzen kann man zweierlei Arten unterscheiden, nämlich stark- und schwachpurpurn, je nachdem die Blüten stark- bzw. schwachpurpurn sind. Diese Arten von Blüten bzw. Pflanzen können voneinander ziemlich scharf abgegrenzt werden.

2. Beiderlei Arten von purpurnen Mosaikpflanzen sind immer heterozygot. Die Selbstbefruchtung von schwachpurpurn gibt nämlich eine Nachkommenschaft, welche vornehmlich aus ihresgleichen

und auch aus einer geringen Anzahl von starkpurpurn und weiss besteht.   Die Selbstbefruchtung von starkpurpurn gibt eine Nachkommenschaft, welche aus fast gleichen Teilen von zweierlei Mosaikpflanzen besteht; keine weisse Abkömmlinge sind dabei herausgespalten.

3.   Die Selbstbefruchtung von starkpurpurn gibt bisweilen einige Pflanzen, welche ganzfarbigpurpurne Blüten tragen und welche sich als heterozygot erwiesen haben.   Es ist höchst wahrscheinlich, dass weitere Versuche zur Entstehung von ganzfarbigpurpurnen Homozygoten führen mögen.

4.   Weiss, welches nach der Selbstbefruchtung von schwachpurpurn entstanden ist, hat sich als homozygot erwiesen.

5.   Auf Grunde der Versuchsresultate können wir sagen, dass bei unseren Mosaikpflanzen zweierlei reine Gameten (weiss und purpurn) und ein unreines Gamet (Mosaikgamet) ausgeschieden werden.   Kein MENDELsches Verhalten ist nachgewiesen worden.

6.   Der Unterschied von zweierlei purpurnen Mosaikpflanzen und ihr Verhalten bei der Selbstbefruchtung werden vermittelst einer Hypothese erklärt, wonach jede von zweierlei Genenarten, den Farbstoff bildenden und ihn nicht bildenden, in einer mehr oder minder grossen Anzahl in der Zygote oder in der Gamete vorhanden ist, um damit das Phänomen der kumulativen Polymerie zu verursachen und der Mosaikgrad durch deren relative Menge bestimmt wird (Kombinations- oder Konkurrenzwirkung von beiderlei Genenarten).

7.   Die Kreuzung zwischen schwachpurpurner Mosaikpflanze und weiss (=cc) gab in $F_1$ die dreierlei Arten von Nachkommen, von denen jede in bezug auf ihr Verhalten in weiteren Generationen untersucht worden ist.

8.   Im Verlaufe solcher Generationen wurden unter anderen Pflanzen erhalten, welche mosaikartig orange und weiss gefärbte Blüten trugen, welche ihrerseits entweder schwach- oder starkorange waren.   Die Pflanzen sind auch entweder schwach- oder starkorange, je nachdem die von ihnen getragenen Blüten schwach- bzw. starkorange sind; beiderlei Arten von Blüten bzw. Pflanzen sind voneinander ziemlich scharf unterscheidbar.

9.   Das erbliche Verhalten der beiderlei Arten von orange Mosaikpflanzen stimmt wesentlich mit dem von purpurnen überein. Jede von beiderlei orange Mosaikpflanzen ist immer heterozygot: starkfarbig spaltet immer schwachfarbige heraus und umgekehrt, und zwar derart, dass beim ersteren Falle ungefähr gleiche Teile von bei-

derlei Nachkommen ausgegeben und beim letzteren weit mehr schwach-
farbige als starkfarbige herausgespalten werden. Weiss, welches
nicht selten nach der Selbstbefruchtung der orange Mosaikpflanzen
entsteht, ist homozygot.

    10.    Die Resultate einiger anderen Kreuzungen werden kurz ange-
geben.

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### Erklärung der Tafel XXII

#### Alle Figuren in natürlicher Grösse

Fig. 1.—Schwachpurpurne Mosaikblüte.

Fig. 2.—Starkpurpurne Mosaikblüte. Einige etwas breite purpurne Streifen.

Fig. 3.—Starkpurpurne Mosaikblüte. Zwei Kronenblätter gänzlich und zwei
andere teilweise ganzfarbigpurpurn.

Fig. 4.—Schwachorange Mosaikblüte.

Fig. 5-6.—Starkorange Mosaikblüte. Blüte in Fig. 6 etwas intensiver gefärbt
als bei derselben in Fig. 5.

Fig. 7.—Starkorange Mosaikblüte mit gänzlich oder teilweise ganzfarbigorange
Kronenblättern.

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# Anhang

ABKÜRZUNGEN.—*pm*, schwachpurpurne Mosaikpflanze; *PM*, starkpurpurne Mosaikpflanze; *om*, schwachorange Mosaikpflanze; *OM*, starkorange Mosaikpflanze; *w*, weiss; *W*, weissartig; *gfp*, ganzfarbigpurpurn; *gfo*, ganzfarbigorange.

## TABELLE II. A (1922)

| Individuen-Nr. | Mosaikpflanzen | *W* | *w* | Summe |
|---|---|---|---|---|
| a.   Aus *pm* | | | | |
| 1 | 12 | 1 | 1 | 14 |
| 2 | 16 | 2 | 1 | 19 |
| 3 | 22 | | 5 | 27 |
| Summe | 50   3    —53— | | 7 | 60 |
| | | | 7 | 60 |
| % | 90 | | 10 | |
| b.   Aus *PM* | | | | |
| 1 | 16 | | | |
| 2 | 30(1) | | | |
| 3 | 38 | | | |
| Summe | 84 (=100%) | | | |
| c.   Aus *w* | | | | |
| 1 | | 3 (=75%) | 1 (=25%) | 4 |

## TABELLE III. A (1923)

| Individuen-Nr. | | *pm* | *PM* | *W* | *gfp* | *w* | Summe |
|---|---|---|---|---|---|---|---|
| a.   Aus *pm* | | | | | | | |
| Aus *pm* 1, Tab. II. B | 1 | 4 | | | | | 4 |
| | 2 | 18 | 2 | | | 1 | 21 |
| | 3 | 11 | 1 | | | 4 | 16 |
| | 4 | 4 | | | | 2 | 6 |

(1)  Unter diesen Nachkommen befanden sich einige mit einzelnen roten Ästen, welche ganzfarbigpurpurne Blüten tragen.

## TABELLE III. A (1923)    *(Fortsetzung)*

| Individuen-Nr. | | *pm* | *PM* | *W* | *gfp* | *w* | Summe |
|---|---|---|---|---|---|---|---|
| **a.   Aus *pm*   (*Fortsetzung*)** | | | | | | | |
| Aus *pm* 2, Tab. II. B | 5 | 7 | 2 | 1 | | 7 | 17 |
| | 6 | 10 | 2 | | | 5 | 17 |
| | 7 | 11 | 6 | | | | 17 |
| | 8 | | 1 | | | | 1 |
| | 9 | 12 | 14 | | | 7 | 33 |
| Aus *pm* 3, Tab. II. B | 10 | 12 | 1 | | | 10 | 23 |
| Summe | | 99 | 29 | 1 | | 36 | 165 |
| % | | 60,0 | 17,6 | 0,6 | | 21,8 | |
| **b.   Aus *PM*** | | | | | | | |
| 1 | | 7 | 3 | | | | 10 |
| 2 | | 6 | 3 | | 1 | | 10 |
| 3 | | 3 | | | | | 3 |
| 4 | | 2 | 5 | | | | 7 |
| 5 | | 21 | 37 | | 3 | | 61 |
| 6 | | 18 | 12 | | 5* | | 35 |
| 7 | | 17 | 5 | | 2 | | 24 |
| 8 | | 74 | 65 | | 11 | | 150 |
| 9 | | 2 | 12 | | 4 | | 18 |
| 10 | | 11 | 11 | | 1 | | 23 |
| 11 | | 18 | 23 | | | | 41 |
| 12 | | 17 | 5 | | 2 | | 24 |
| Summe | | 122 | 116 | | 18 | | 256 |
| % | | 47,7 | 45,3 | | 7,0 | | |
| **c.   Aus *W*** | | | | | | | |
| 1 | | 23 | 10 | 1 | | 2 | 36 |
| 2 | | | 1 | | | 2 | 3 |
| 3 | | | | 1 | 1 | 11 | 13 |
| 4 | | | | | | 2 | 2 |
| 5 | | | 1 | | 1 | 11 | 13 |
| 6 | | | | 16 | | 10 | 26 |
| Summe | | 23 | 11 | 19 | 2 | 48 | 103 |
| % | | 22,3 | 10,7 | 18,4 | 1,9 | 46,6 | |

## TABELLE III. A (1923)    (*Fortsetzung*)

| Individuen-Nr. | *pm* | *PM* | *W* | *gfp* | *w* | Summe |
|---|---|---|---|---|---|---|
| | | | d.    Aus *w* | | | |
| 1 | | | | | 39 | 39 |
| 2 | | | | | 2 | 2 |
| 3 | | | | | 5 | 5 |
| Summe | | | | | 46 (=100%) | 46 |

## TABELLE VI. A (1922)

| Individuen-Nr. | *w* | *W* | *gfo* | Summe |
|---|---|---|---|---|
| 1 | 22 | 1 | | 23 |
| 2 | 8 | 1 | 1 | 10 |
| 3 | 43 | 21 | | 64 |
| 4 | 23 | | | 23 |
| 5 | 38* | 16** | | 54 |
| 6 | 18 | | | 18 |
| 7 | 25 | | | 25 |
| 8 | 35 | 4 | | 39 |
| 9 | 36 | 9 | | 45 |
| 10 | 31 | | | 31 |
| 11 | 32 | 7 | | 39 |
| 12 | 26 | 2 | | 28 |
| Summe | 337 | 61 | 1 | 399 |
| % | 84,5 | 15,3 | 0,2 | |

## TABELLE VII (1923)

Selbstbefruchtung von $F_2$-weiss aus $pm \times w$ (I)

| Individuen-Nr. | | *w* | Summe |
|---|---|---|---|
| | 1 | 16 | 16 |
| | 2 | 63 | 63 |
| Aus Ind.-Nr. 6, Tab. VI. A, mit * markiert | 3 | 38 | 38 |
| | 4 | 73 | 73 |
| | 5 | 48 | 48 |
| Summe | | 238 (=100%) | 238 |

## Tabelle VIII. A (1923)

| Kreuzung | Nachkommen | | | Summe |
|---|---|---|---|---|
| | Individuen-Nr. | *gfo* | *gfp* | |
| *W* (Nr. 5, Tab. VI. A, m. * markiert) | 1 | 11 | | 11 |
| | 2 | 25 | | 25 |
| | 3 | 31 | | 31 |
| × | 4 | 29 | | 29 |
| cc | Summe | 96 (=100%) | | 96 |
| *W* (Nr. 5, Tab. VI. A, m. ** markiert) | 1 | 9 | 2 | 11 |
| | 2 | 2 | 1 | 3 |
| | 3 | 5 | 1 | 6 |
| | 4 | 13 | 7 | 20 |
| | 5 | 8 | 10 | 18 |
| × | Summe | 37 | 21 | 58 |
| CC | | 63,8% | 36,2% | |

## Tabelle IX. A (1922)

| Individuen-Nr. | *pm* | *om* | *w* | Summe |
|---|---|---|---|---|
| 1 | 29 | 2 | 13 | 44 |
| 2 | 34 | 10 | 12 | 56 |
| 3 | 29 | 2 | 8 | 39 |
| Summe | 92 | 14 | 33 | 139 |
| % | 66,1 | 10,2 | 23,7 | |

## Tabelle X. A (1923)

| Individuen-Nr. | pm | PM | om | w | rot | Summe |
|---|---|---|---|---|---|---|
| a.  Aus pm | | | | | | |
| 1 | 11 | | 6 | 3 | | 20 |
| 2 | 21 | 10 | 14 | 11 | 1 | 57 |
| 3 | 6 | 3 | | 3 | | 12 |
| 4 | 5 | | | | | 5 |
| 5 | 3 | 1 | | | | 4 |
| 6 | 11 | | 4 | 3 | | 18 |
| 7 | 8 | | 7 | 5 | | 20 |
| 8 | 5 | | 1 | 1 | | 7 |
| 9 | 2 | 3 | 1 | 2 | | 8 |
| 10 | 6 | | 2 | 2 | | 10 |
| Summe | 78 | 17 | 35 | 30 | 1 | 161 |
| % | 48,4 | 10,6 | 21,7 | 18,6 | 0,6 | |
| b.  Aus w | | | | | | |
| 1 | | | | 35 | | |
| 2 | | | | 20 | | |
| 3 | | | | 39 | | |
| 4 | | | | 38 | | |
| Summe | | | | 132 (=100%) | | |

## Tabelle XI. A (1922)

| Individuen-Nr. | om | w | Summe |
|---|---|---|---|
| 1 | 39 | 8 | 47 |
| 2 | 52 | 9 | 61 |
| Summe | 91 | 17 | 108 |
| % | 84,3 | 15,7 | |

## TABELLE XII. A (1923)

| Individuen-Nr. | om | w | Summe |
|:---:|:---:|:---:|:---:|
| a. Aus om | | | |
| 1 | 38 | 11 | 49 |
| 2 | 1 | 25 | 26 |
| 3 | 15 | 5 | 20 |
| 4 | 54 | 1 | 55 |
| Summe | 108 | 42 | 150 |
| % | 72 | 28 | |
| b. Aus w | | | |
| 1 | 1 | 2 | 3 |
| 2 | | 44 | 44 |
| 3 | | 22 | 22 |
| 4 | 2 | 29 | 31 |
| 5 | 1 | 2 | 3 |
| Summe | 4 | 100 | 104 |
| % | 3,9 | 96,1 | |

## TABELLE XIII. A (1924)

| Individuen-Nr. | om | OM | w | Summe |
|:---:|:---:|:---:|:---:|:---:|
| 1 | 2 | 1 | 3 | 6 |
| 2 | 5 | 5 | | 10 |
| 3 | 8 | 2 | 3 | 13 |
| 4 | 13 | 1 | 5 | 19 |
| 5 | 10* | 9 | | 19 |
| 6 | 3 | | 1 | 4 |
| Summe | 41 | 18 | 9 | 68 |
| % | 60,3 | 26,5 | 13,2 | |

## Tabelle XIV. A (1925)

| Individuen-Nr. | *OM* | *om* | *gfo* | rot | Summe |
|---|---|---|---|---|---|
| a. Aus *OM* | | | | | |
| 1 | 6 | 1 | 2 | | 9 |
| 2 | 22 | 6 | | 3 | 31 |
| 3 | 14 | 19 | 2 | | 35 |
| 4 | 10 | 2 | 5 | | 17 |
| 5 | 37 | 34 | 2 | | 73 |
| 6 | 30 | 40 | 1 | | 71 |
| 7 | 37 | 36 | 3 | | 76 |
| Summe | 156 | 138 | 15 | 3 | 312 |
| % | 50,0 | 44,3 | 4,8 | 0,9 | |
| b. Aus *om* | | | | | |
| 1 | | 3 | | | 3 |
| 2 | 1 | 16 | | | 17 |
| 3 | 2 | 33 | | | 35 |
| 4 | 3 | 46 | | | 49 |
| Summe | 6 | 98 | | | 104 |
| % | 5,8 | 94,2 | | | |

## Tabelle XV. A (1925)

| Individuen-Nr. | *OM* | *om* | *w* | Summe |
|---|---|---|---|---|
| 1 | 7 | 1 | | 8 |
| 2 | 14 | 22 | 7 | 43 |
| 3 | 11 | 10 | 13 | 34 |
| 4 | | 2 | | 2 |
| Summe | 32 | 35 | 20 | 87 |
| % | 36,8 | 40,2 | 23,0 | |

TABELLE XVII. A (1924)

| Individuen-Nr. | _pm_ | _PM_ | _om_ | _w_ | Summe |
|:---:|:---:|:---:|:---:|:---:|:---:|
| 1 | 1 | | 5 | | 6 |
| 2 | 4 | | 3 | | 7 |
| 3 | 6 | | 2 | | 8 |
| 4 | 27 | | 25 | 5 | 57 |
| Summe | 38 | | 35 | 5 | 78 |
| % | 48,7 | | 44,9 | 0,65 | |

TABELLE XVIII. A (1923)

| Individuen-Nr. | _pm_ | _PM_ | _gfp_ | Summe |
|:---:|:---:|:---:|:---:|:---:|
| 1 | 8 | 14 | 4 | 26 |
| 2 | 4 | 2 | 2 | 8 |
| 3 | 27 | 7 | 8 | 42 |
| 4 | 2 | | | 2 |
| 5 | 12 | 5 | | 17 |
| 6 | 10 | 4 | | 14 |
| Summe | 63 | 32 | 14 | 109 |
| % | 57,8 | 29,4 | 12,8 | |

TABELLE XIX. A (1924)

| Individuen-Nr. | _gfp_ | _gfo_ | _pm_ | _PM_ | _om_ | Summe |
|:---:|:---:|:---:|:---:|:---:|:---:|:---:|
| 1 | 24 | 7 | 4 | 4 | | 39 |
| 2 | 3 | 1 | 1 | 1 | | 6 |
| 3 | 29 | 7 | 5 | 6 | 1 | 49 |
| Summe | 56 | 15 | 10 | 11 | 1 | 93 |
| % | 60,2 | 16,1 | 10,8 | 11,8 | 1,1 | |

## TABELLE XX. A (1925)

| Individuen-Nr. | pm | PM | gfp | Summe |
|---|---|---|---|---|
| 1 | 5 | 2 | 34 | 41 |
| 2 | 1 | 3 | 37 | 41 |
| 3 | | 3 | | 3 |
| 4 | | 3 | 15 | 18 |
| 5 | 2 | 12 | 27 | 41 |
| 6 | | | 24 | 24 |
| 7 | | 1 | 12 | 13 |
| 8 | 2 | 1 | 29 | 32 |
| Summe | 10 | 22 | 171 | 203 |
| % | 5,0 | 10,8 | 84,2 | |

## TABELLE XXI. A (1925)

| Individuen-Nr. | om | gfo | gfp | w | Summe |
|---|---|---|---|---|---|
| 1 | 80 | 11 | 2 | | 93 |
| 2 | 71 | | | | 71 |
| 3 | 19 | | | 4 | 23 |
| 4 | 53 | | | | 53 |
| Summe | 223 | 11 | 2 | 4 | 240 |
| % | 92,9 | 4,5 | 0,9 | 1,7 | |
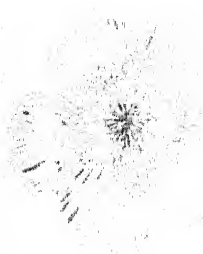
1
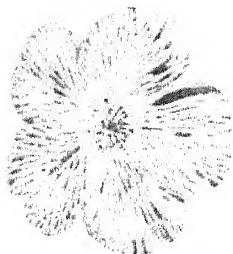
2
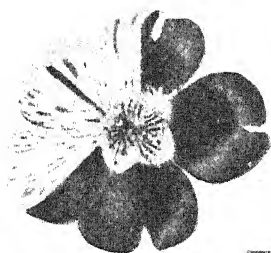
3
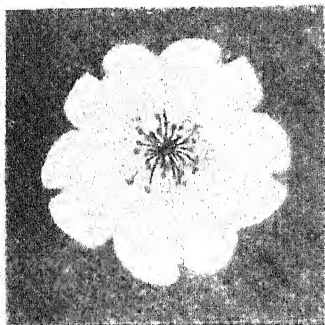
4
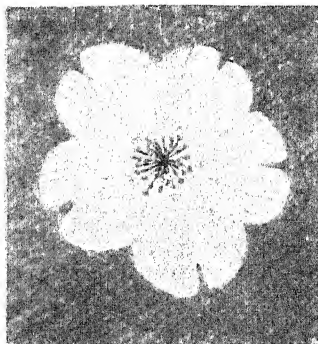
6
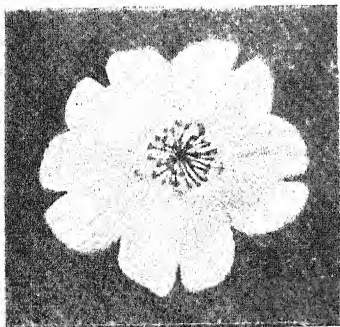
5
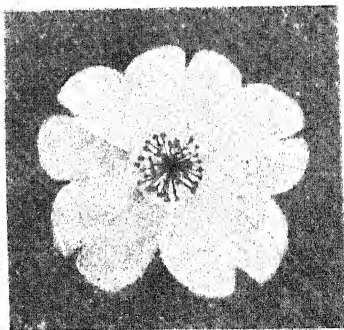
7

# On the Seed-bearing Leaves of *Ginkgo*

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## Introduction

In the present paper I am going to record some of the morphological observations on the *Ginkgo* flower, with the special reference to the staminody and carpellody.

The brilliant discovery of the motile sperm-cells in *Ginkgo biloba* and *Cycas revoluta* by HIRASE and IKENO in 1896 was one of the greatest deeds ever made in the realm of the plant morphology. It has furnished a beautiful confirmation towards the homology which exists between the Gymnosperms and Vascular Cryptogams. Another no less remarkable fact which demonstrates the close relationship between the two I will try to describe in the following lines. It will not only explain the phylogeny of the *Ginkgo* ovule, but also furnish an evidence of its foliar nature. I was attracted to this investigation, partly on account of the great antiquity of the *Ginkgo* family, partly on that of the endemism of *Ginkgo biloba*, L.

## Systematic Record[1]

*Ginkgo biloba* was first introduced to Europe by Engelbr. KAEMPFER in 1692 (19) and planted in a garden in Utrecht. The English botanist GORDON sent it in 1754 to the great LINNAEUS, who says (20) " Ginkgo vel Gin An, vulgo Itsjo." LINNAEUS saw no flower at that time, so no definite systematic position was given to

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(1) The author thanks very much Dr. NAKAI who kindly furnished him the data on the systematic part of this paper.

it in his Systema Naturae. The flower of *Ginkgo* was seen first in Kew Botanical Garden in 1760, and it was the male one.

MURRAY (1784) (23), VITMANN (1792) (46), and THUNBERG (1792) (44) described it in their books.

SMITH (38) called it *Salisburia adiantifolia*, SMITH; he planted it in the Botanical Garden of Vienna in 1799 and DE CANDOLLE observed its female flower in 1814.

SIEBOLD and ZUCCARINI (37) wrote about it in 1841.

REUNIER (1854) called it *Salisburia macrophylla*, R.

RICHARD (1826) (25) called it *Salisburia Ginkgo*.

PARLATORE (1860) (24) noticed it in the famous DE CANDOLLE's book.

ELWES and HENRY (6) distinguished five variations, viz: *Ginkgo biloba*, L. var. *variegata*, HENRY, *Ginkgo biloba*, L. var. *pendula*, HENRY, *Ginkgo biloba*, L. var. *macrophylla-laciniata*, HENRY, *Ginkgo biloba*, L. var. *triloba*, HENRY, *Ginkgo biloba*, L. var. *fastigiata*, HENRY.

## Materials and Methods

At first freehand sections were used for observation, and when necessary phloroglucin and hydrochloric acid were used for studying the vascular bundles. The mode of vascular distribution in the peduncle was studied by a careful count of the number of vascular bundles at its various levels. The materials were mostly preserved in spirit, sometimes in formalin-alcohol. Subsequently microtome sections were used.

## Locality

In the yard of the Buddhist temples Honkokuzi, Zyôtakuzi and Hasedera situated on one side of River Huzi in Simoyama at Minobu, province Kai, we see female trees bearing carpellodial leaves, while in a shrine at Kamiyagizawa on the opposite side of the same River male trees bearing staminodial leaves are found. Dr. T. MAKINO told me that an old female *Ginkgo* tree showing the abnormality is standing in Murakami, near Niigata. Prof. S. KUSANO has once written me that Prof. TROTTER (43) in "R. Scuola sup. d'Agricoltura, Portici" is studying the carpellodial leaves of *Ginkgo*.

Near Tôkyô, though I have examined many trees, I can find neither carpellodial nor staminodial leaves. In the Buddhist temples Hurukawayakusi at the side of River Rokugô, near Kawasaki, Zenpukuzi at Azabu, Kôenzi at Koisikawa, Tensozin Shrine at Ôtuka,

Ôzi-Gongen, Kisimozin, Kainan Shrine at Misaki, Tibadera temple at Tiba, there are old *Ginkgo* trees, but all of them show simply the tendency to carpellody.

## Historical Reviews

In the following lines I will only consider among others the most important and striking views advanced by various authors in respect to the subjects more or less allied to my investigation.

The morphology of *Ginkgo* which was an entirely untrodden field previous to 1712 (19) became later the subject of studies by VAN TIEGHEM (45), STRASBURGER (41, 42), SACHS (26), EICHLER (5), and CĚLAKOVSKÝ (2).

VAN TIEGHEM (1868) (45) with the aid of anatomical methods, came to the conclusion that the female flower of *Ginkgo* corresponds merely to a single leaf, the peduncle (flower-stalk) being homologous to the petiole of a foliage-leaf, and the two ovules to the two lobes of a typical *Ginkgo* leaf. The flower bearing more than two ovules _3, 4, 5, seldom 6_is comparable to a multilobed leaf.

STRASBURGER (1872) (41, 42) considered the female flower as an inflorescence supporting an ovule, and not as a single leaf, in short, not as a phyllome-, but as a caulome-organ.

SACHS (1874) (26) stated that the female flower springs from the axil of foliage leaves belonging to short lateral branches which annually produce new rosettes of leaves. He thinks that each single flower consists of a stalk-like elongated axis which bears immediately beneath its apex two or more lateral ovules.

WARMING (1877) (47) did not consider the ovule as a leaf, but as a lobe of a leaf. He thinks that both *Ginkgo* and *Cycas* ovules should be homologous to the fertile lobes of *Ophioglossum* frond.

DELPINO (1889) (4) considers each cone of Conifers as a flower. He says that between the female flower of Conifers and *Ophioglossum* there exists a wonderful homology.

EICHLER (1873) (5) criticized all views above cited and takes the fleshy parts of the seed for the inner integument of an ovule and the collar at the base of the ovule for its outer integument. Further, he has spoken of the collar as a rudimentary carpel and the peduncle as well as its two ovules as a single flower. According to his latest view the female flower is a real single flower, but the flower-

stalk (peduncle) is a small shoot, and the cup-shaped swelling at the base of the ovule the rudimentary carpel.

VAN TIEGHEM (1891) (45) described the vascular system of the peduncle and its subtending leaf and regarded the collar of each ovule as a rudimentary arillus.

CĚLAKOWSKÝ (1890) (2) considers that the peduncle is a shoot bearing two or more carpels, each carpel being much reduced and transformed in its terminal portion into an ovule.

Of various views concerning the morphological nature of the *Ginkgo* flower those above cited are the chief ones. It may be here remarked that none of these is based upon the investigation of abnormalities of the organ in question. In 1891 Dr. SHIRAI (36) first found in the province Kai a strange *Ginkgo* tree showing remarkable abnormalities, and sent the materials collected there to Dr. FUJII who was at that time studying *Ginkgo*. The latter author (1896) (7) studied these abnormalities which he calls "Staminody" and "Carpellody," and published an important contribution towards the solution of the vexed question of the *Ginkgo* morphology. In both staminody and capellody of the foliage leaves we have indeed an excellent instance of the revelation of the nature of certain structures which are under normal conditions utterly obscure. The following conclusions were drawn by FUJII from a study of these interesting abnormalities. The ovule is an organ of foliar nature, while the cup-shaped swelling at its base is the reduced portion of the carpellary leaf. The ovule of *Ginkgo* is the marginal formation in the sporophyll. The normal seed-stalk is the floral axis, whose apical bud is usually suppressed, and which bears only two rudimentary carpels. The elongated stalklet of the ovule of *Ginkgo* which is occasionally developed is not a simple outgrowth, as has been considered by some authors, but the petiole of the carpellary leaf developed alternately along the floral axis.

Recently SHAW (1916) (35) studied the female flower of *Ginkgo*, and SCHAFFNER (1927) (32) considered *Ginkgo* as a flowerless plant, but I will not go in this paper into the discussion of their views.

## Description

*Ginkgo biloba* is a deciduous tree with long as well as short shoots (*brachyblast*); foliage leaves are fan-shaped and dichotomously veined, their upper margin is wavy, usually bilobed, sometimes

many-lobed in young trees, entire in old trees (Text-fig. 1).  It is dioecious ; each flower is borne singly in the axil of the uppermost scaly leaf and the lowermost foliage leaf.  Male flowers form a loose, elongated short-stalked spike, stamens with two pollen-sacs
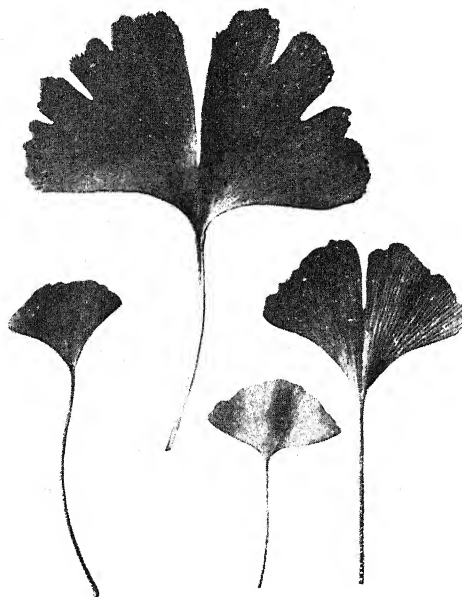


Fig. 1.  Bilobed and entire leaves

and a very small round terminal scale ; the number of male flowers on one brachyblast is mostly 6 ( ♂ 52 ! s. Table I).  Female flowers are long-stalked, usually with two ovules placed opposite to each other near the apex of the stalk.  Their number in one brachyblast

## TABLE  I

### Number of Male and Female Flowers on one Brachyblast.

| No. of Flowers on one Brachyblast | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| No. of Brachyblasts | 0 | 0 | 3 | 12 | 27 | 76 | 45 | 37 | 0 |
| | | | ♂3+ ♀0 | ♂11+ ♀1 | ♂21+ ♀6 | ♂52+ ♀24 | ♂13+ ♀32 | ♂0+ ♀37 | |

In this Table $\dfrac{12}{♂11+ ♀1}$, for example, means that 11 out of 12 brachyblasts examined 11 bear female and 1 male flower.

is mostly 8, of which only one comes to maturity and the others
soon die and fall down (♀ 37 ! s. Table I). Ovules with a single
integument and the two-lipped micropyle is partially enclosed at its
base in a small cup-shaped swelling.  Only one ovule in each flower
becomes usually ripe seed, and the drupe as well as its stony part
are two-angled.

In young trees we never see short shoots of great length, but
in old trees they become generally much elongated, attaining often



Fig. 3.   Pseudo-branched brachyblast

Fig. 2.   Much elongated brachyblast com-
posed of 35 transverse zones

more than 7 cm. in length (s. Text-fig. 2 and Pl. XXV, fig. 1–6)
and sometimes branching pseudo-dichotomously (s. Text-fig. 3 and
Pl. XXV, fig. 1), and such we consider as senile forms.  Not only
the elongated brachyblasts, but also carpellodial and staminodial
leaves (p. 225 ff.) and the "titi" (p. 228 ff.), which are described
later in this paper are considered as senile forms.  Though it is

not clear what significance all these senile forms have in phylogenetical sense, they may be considered at any rate as structures special to the trees of old age, and not at all as pathological ones.

We see in the surface of each short shoot 15–24, seldom 35 transverse zones regularly arranged (Text-fig. 2, 3; Pl. XXV, fig. 1–6), each zone corresponding to one year's length growth and bearing a certain number of persistent bases of leaves (Table II). The short shoot thus resembles somewhat the so-called armoured trunks of certain Cycadaceae.

### TABLE  II

#### Frequency of the Zone Number in one Brachyblast

| No. of Zones | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency | 0 | 0 | 0 | 0 | 0 | 5 | 10 | 10 | 10 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 2 | 1 | 2 | 1 | 1 | 1 | 1 |
| % | 0 | 0 | 0 | 0 | 0 | 10 | 20 | 20 | 20 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 16 | 4 | 2 | 4 | 2 | 2 | 2 | 2 |

Carpellody and staminody are seen only on some leaves of old elongated short shoots of a tree, while in all others on this same tree simply indications of abnormality are detectable. Young short shoots have always normal leaves.

The number of ovules or pollen-sacs formed upon a single carpellodial or staminodial leaf respectively varies between 1–8 or more (s. Table III). The formation of such ovules or pollen-sacs always takes place along the margin of the leaf. When a great number of

### TABLE  III

#### Number of Ovules formed on a Carpellodial Leaf

| No. of Ovules on a Leaf | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Frequency | 2 | 40 | 25 | 19 | 6 | 5 | 2 | 1 |
| % | 2 | 40 | 25 | 19 | 6 | 5 | 2 | 1 |

ovules or pollen-sacs are developed upon one leaf, they are very irregular in form, but when they are only few in number their form is nearly normal (s. Pl. XXIV, fig. 1 and fig. 2). The ovules and fruits formed upon the leaf are abortive and always smaller than the normal ones. Each ovule in a carpellodial leaf is partially enclosed as its base in a cup-shaped swelling just as in normal one, and this swelling passes gradually into the leaf. Each

"Anlage" of ovule appears at the margin of a foliage leaf, at the beginning of April, as a fine linear ridge. Day by day, buds begin to swell up gradually, and after brown bud scales had fallen off green leaves may be seen already, and the ovule-bearing leaves are clearly distinguishable (Pl. XXIII, fig. 2–3).

The anatomical examination of carpellodial leaves in this stage shows loose mesophyll cells between the veins parallel to the plane of the leaf surface (Pl. XXVI, fig. 3). Gradually the ridge above stated grows up, till it looks like a normal ovule, and the tissue of the integument develops just in the same manner as in normal case (s. Pl. XXIII, fig. 4, 5, 6). By the end of August the ridge is differentiated into the three distinct tissues, viz. an outer layer of large thin-walled cells with many mucilage-cavities, a middle layer of small isodiametric cells, and an inner layer of large thin-walled cells loosely packed together (Pl. XXIV, fig. 3).

The petiole of carpellodial leaf is normal in length, but that of staminodial one is often much reduced in this respect. In order to throw some light upon the nature of the carpellodial leaf, the writer will proceed to the comparison of its petiole with that of the foliage leaf, and the flower-stalk. First of all he studied anatomically the relation between the petiole of foliage leaf and the flower-stalk. A great number of petioles and peduncles were examined by him. Externally the flower-stalk sometimes resembles the petiole of a leaf, as VAN TIEGHEM has stated, but there is between them a great difference in anatomical structure.

In the petiole run two vascular bundles, each of which divides at the summit of the petiole; the outer two branches follow the outer edge of the lamina, giving off a succession of forked veins. A transverse section of a petiole of foliage leaf shows without exception two fibro-vascular bundles (s. Pl. XXIV, fig. 5), while that of a flower-stalk has four bundles though very rarely the latter may unite into three or divide into five. (s. Pl. XXIV, fig. 4). In the petiole of a carpellodial leaf we find constantly two bundles similarly situated as in the petiole of the foliage leaf. In the cross sections of the flower-stalk bearing more than four ovules (s. Table IV, Text-fig. 4, Pl. XXV, fig. 7), where the flower-stalk bearing various numbers of ovules are represented we find as a rule as many bundles as there are ovules, and each bundle bifurcates during its course, previous to its entrance to the stalklet of each ovule. In a cross section of the stalklet we see a pair of fibrovascular bundles

## TABLE IV

### Frequency of Ovule Number on Female Flower-stalk

| No. of ovules on Female Flower-Stalk | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Frequency | 2 | 854 | 70 | 20 | 54 |
| % | 0.1 | 42.7 | 35 | 10 | 27 |
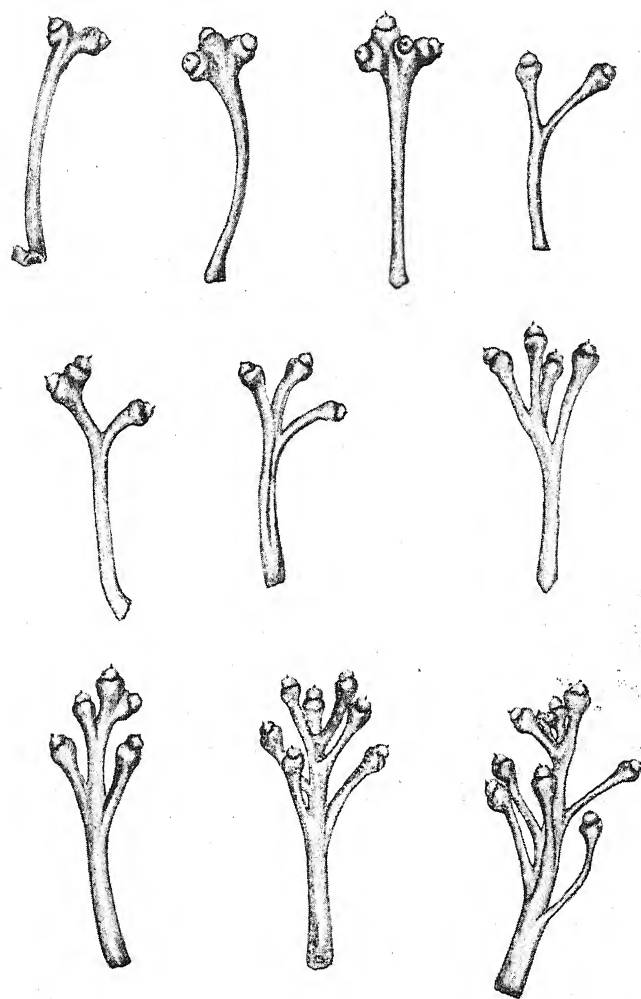


Fig. 4. Variation of Number of Normal Female Flowers

similarly situated as those in the petiole of the foliage leaf, so that
it may well be considered to be equivalent to a leaf-stalk.

From what was above discussed, we may conclude that *the flower-
stalk is a caulome-organ, while the leaf-stalk of normal as well as car-
pellodial leaves and stalklet of normal ovules are phyllome-organs.*

## " Titi "

Another peculiarity of *Ginkgo biloba* is the formation of the so-
called " titi " (nipple).   It is commonly met with in old trees, and
this may be considered as a senile form; its nature and development



Fig. 5.  " Titi "



Fig. 6.  " Titi "

has been studied by FUJII (1895) (8, 9), who considers it as a "Masercylinder."

Externally the "titi" is a cylindrical body with a round tip, which generally grows downwards from the underside of a large branch of the tree (s. Text-figs. 5–6).

My observations on the "titi" have been made near Tôkyô and especially in the yard of Zenpukuzi at Azabu and Hurukawayakusi at Kawasaki. The trees standing there have so many hanging "titi" that they look very strange. There are many other so-called "titi-ityô" (nippled *Ginkgo*) in Japan. The largest "titi" which I have ever seen is found in a very old *Ginkgo* tree, in which it measures more than 4 m. in length and 20 cm. in diameter, but
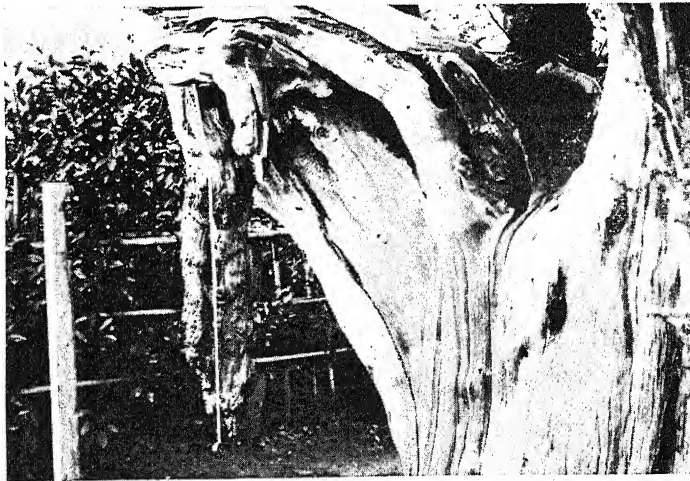


Fig. 7. Dead "titi" (nipple) showing woody part

which is already dead, the hard woody part being exposed externally (s. Text-fig. 7). The formation of "titi" may take place both in male and female trees; it may be considered as a structure special to the trees of old age, viz. as a senile form, and not at all as a pathological one.

It may here be added that we may distinguish two types in respect to the habit of the *Ginkgo* tree. In the one the tall stem stands upright till to the considerable height, where it first comes to branching (Text-fig. 8), while in the other the branching begins at a much lower level, the upright part of the stem being con-

sequently less tall and also relatively larger in its diameter than in
the first type (Text-fig. 9). These two types do not correspond to
the distinction between the male and female stocks ; they may
rather perhaps represent two distinct varieties. The branches borne



Fig. 9. Short-stemmed *Ginkgo* tree at Hatiman,
Kamakura

Fig. 8. Long-stemmed *Ginkgo*
tree at the Tensozin Shrine, Ôtuka

in the tall upright stem of the first type are directed generally
northwards, and this is perhaps due to the action of southern wind
on the growing points in early spring. As to those borne on trees
with low upright stem we see no such phenomena.

## Discussion

Both ovules and anthers of *Ginkgo biloba* are marginal forma-
tions on the sporophylls, while the anthers of *Cycas* are in general
developed on the under surface of staminal leaves (male sporophylls).
The formation of ovules upon the foliage leaves (troposporophyll) of
*Ginkgo* reminds us of the carpellary leaves (female sporophyll) of
*Cycas*, for in both genera the ovules are marginal formations of the
sporophyll. If the latter fact is a conservative character retained
by the staminal leaf of *Ginkgo*, we may consider that *Ginkgo* might
have been derived phylogenetically from some kind of ferns, but
not from the Lycopodiaceae, to which
many other genera of Coniferae are close-
ly related. The drupaceous fruits of
*Ginkgo* and *Cycas* much resemble to each
other. Also the neck of archegonia con-
sists in both equally of two cells.

Long after W. HOFMEISTER (16) wrote
" in dessen Inneren vielleicht Samenfäden
sich bilden," spermatozoids have been
found in *Ginkgo biloba* and *Cycas revoluta*
for the first time in 1896, and the process
of fertilization has been found to be very
similar in both plants. The short shoot
of *Ginkgo* is exactly similar in all essen-
tial morphological features to the trunk
of certain Cycadaceae; that both are
usually simple, though sometimes pseudo-
dichotomously branched is an instance
for it.

In *Ginkgo* the short shoot sometimes
changes to the long shoot (s. Text-fig. 10),
which might perhaps indicate the mode of
phylogenetic origin of normal long shoot.



Fig. 10. Branchyblast chang-
ed into long shoot

The interesting senile forms indicate the close relationship of
*Ginkgo* and *Cycas* to ferns. In fact the Gymnosperms may be a
heterogeneous group and *Ginkgo* may have been derived from a
*Cycas*-like ancester, which has acquired woody nature. *Ginkgo* is a
connecting link between the Cycadaceae and the Coniferae, and we
may well call it " living fossil tree " of now-a-days.

## Summary

By studying carpellodial leaves of *Ginkgo biloba* and comparing them with normal flowers, the writer came to the following results.

1. Leaves bearing seeds and anthers may be considered as senile forms.

2. The so-called collar of fruit is the residual portion of the lamina of carpel leaf.

3. Seed-bearing leaves (Carpellody) are homologous to normal seeds.

4. Normal seed-stalks are floral axis (" caulome-organs.")

5. Ovule and anther are phyllome-organs.

6. Abnormal seed-stalklets are phyllome-organs.

7. The normal entire leaf of *Ginkgo* is the senile form of bilobed leaf, being a transitional stage to carpellodial leaf.

8. The elongated brachyblast is the senile form, recalling the armoured trunk of *Cycas*; both sometimes branch pseudo-dichotomously.

9. The number of male and female flower on one brachyblast varies from 3 to 8; 6 is the mode of the variation.

10. The number of ovules on a carpellodial leaf varies from 1 to 13 but the fibrovascular bundles are constantly two.

11. " Titi " which is a Masercylinder " is also a senile form in *Ginkgo*, but not a pathological product.

December 10, 1928

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# Explanation of Plates XXIII, XXIV, XXV

## PLATE XXIII

Fig. 1. Staminodial or anther-bearing leaves on brachyblast.
Fig 2. Carpellodial or ovule-bearing leaves on brachyblast.
Fig. 3. Carpellodial leaves, each forming ovule anlage.
Fig. 4. Advanced stages of carpellodial leaves.
Fig. 5. Aborted ovules of carpellody, and one normal fruit on brachyblast.
Fig. 6. A brachyblast showing more advanced stage of carpellody.

## PLATE XXIV

Fig. 1. Variation of ovule number on carpellodial leaves.
Fig. 2. A typical carpellodial leaf.
Fig. 3. A cross section of "Anlage" of ovule on carpellodial leaf.
Fig. 4. A cross section of normal flower-stalk showing four bundles.
Fig. 5. A cross section of normal leaf-stalk showing two bundles.

## PLATE XXV

Fig. 1. Various forms of female brachyblasts.
Fig. 2. Male (small) and female (large) brachyblasts.
Fig. 3. Male brachyblasts showing annual zones.
Fig. 4, 5 6. Female brachyblasts showing annual zones.
Fig. 7. Various forms of female flowers.

PLATE XXIII



1



2



3



4



5



6

SAKISAKA photo.

PLATE XXIV



1



3



2



4



5

SAKISAKA photo.

PLATE XXV
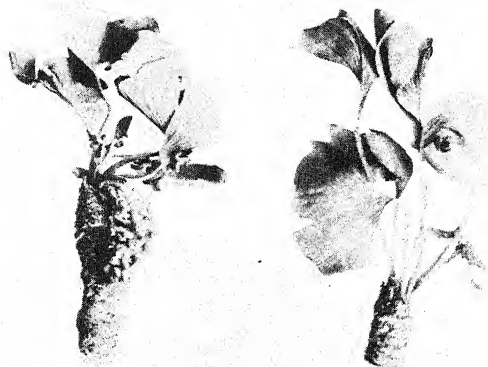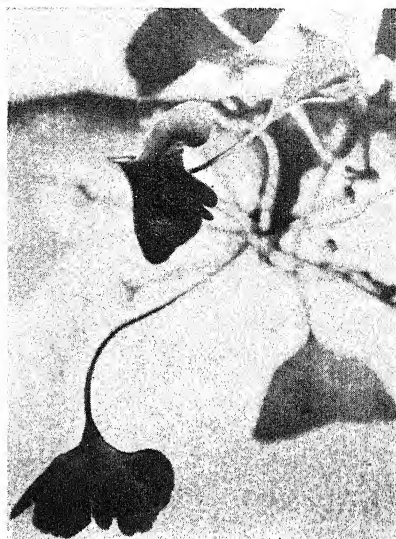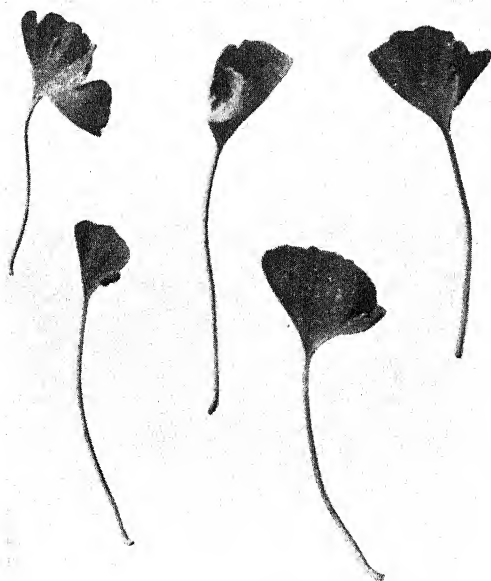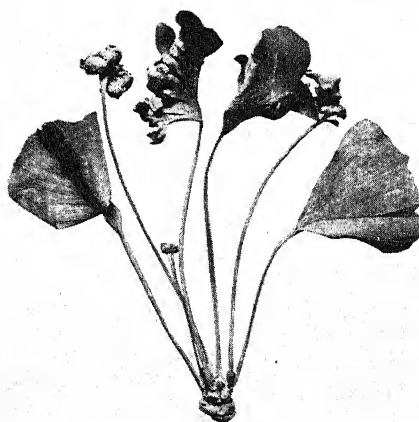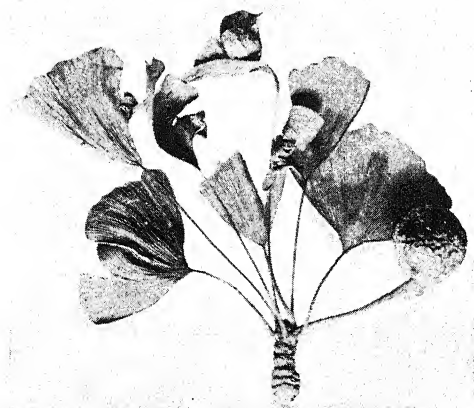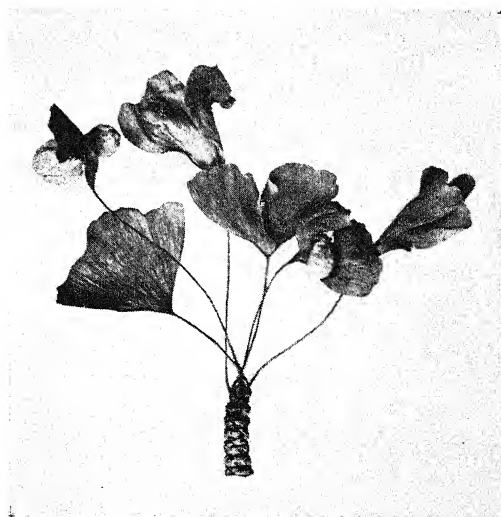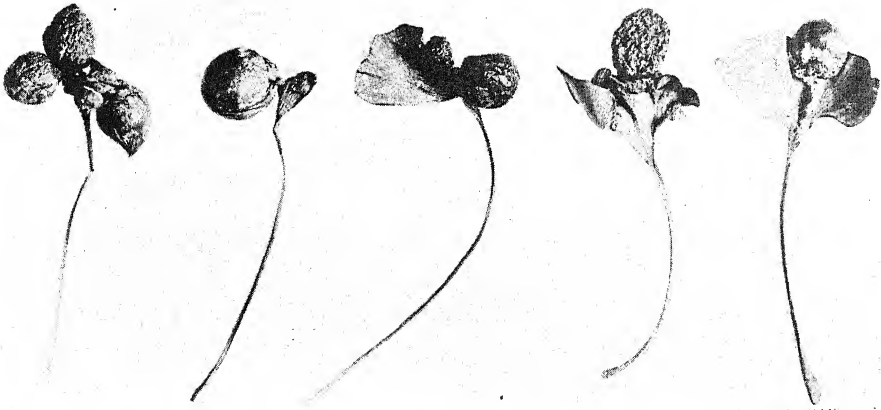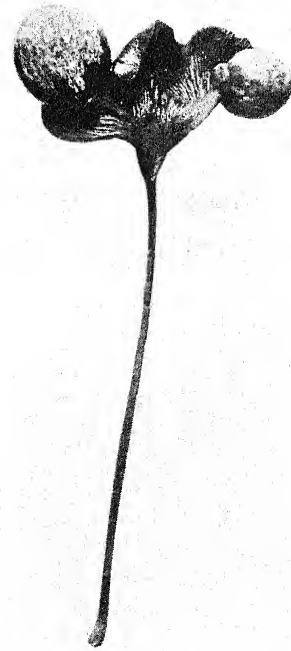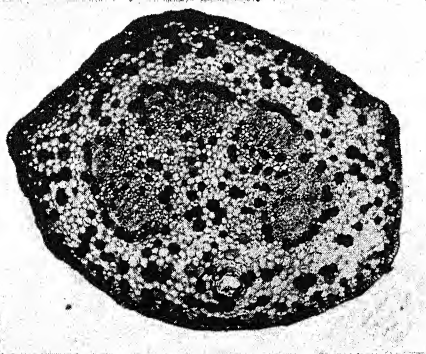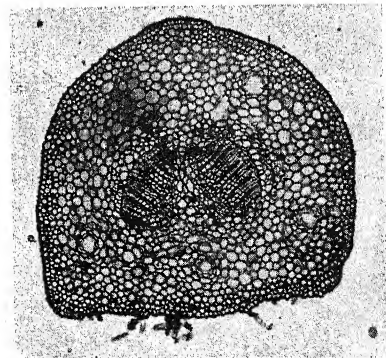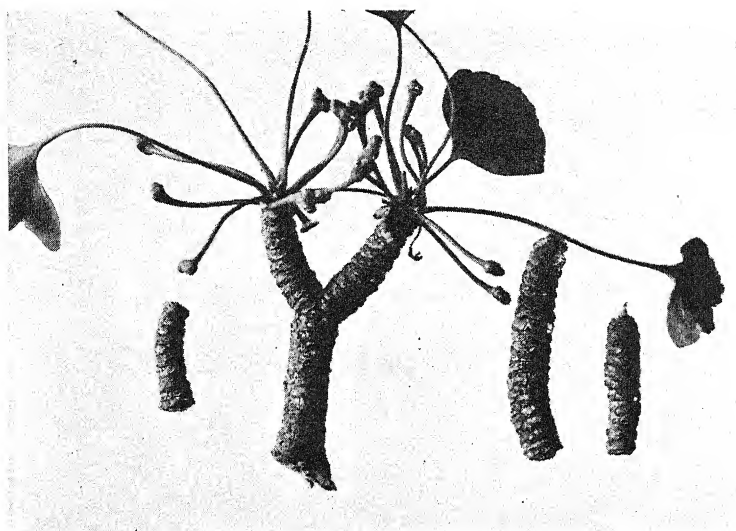


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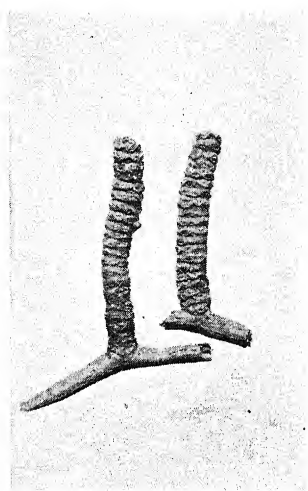
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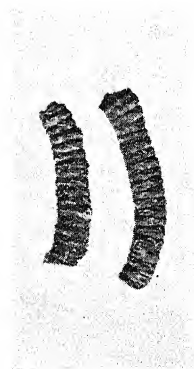
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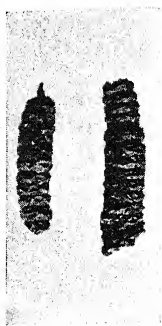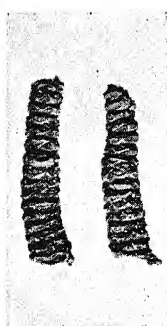
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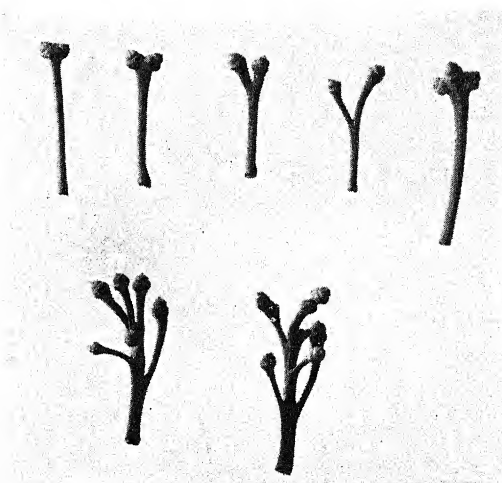
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# Studien über den Einfluss der Aussenbedingungen auf das Aufblühen der Reispflanzen

Von Yakichi NOGUCHI

Hierzu 2 Textabbildungen

(Eingegangen am 15. Dezember 1928)

## Inhaltsverzeichnis

# Einleitung

Um die künstliche Bastardierung der Kulturpflanzen mit Erfolg ausführen zu können, muss die Bestäubung unter möglichst günstigen Aussenbedingungen betrieben werden. Dafür ist die genaue Kenntnis der Blühvorgänge jeder Kulturpflanze sowie die der Beziehung zwischen denselben und den Aussenbedingungen eine unbedingte Erfordernis. Leider betreffend die Reispflanzen hat man aber bisher nur wenige derartige Angaben gehabt. Die Tatsache, dass die Nässe, der Wind und der Regen in der Aufblühzeit die Kornbildung nachteilig beeinflussen, ist schon von KÖRNICKE (12) gefunden worden. Nachdem der Vorteil der Züchtung durch die Bastardierung allgemein bekannt geworden ist, wurden einige auf den Einfluss der Aussenbedingungen betreffende experimentelle Ergebnisse veröffentlicht. Iso (6) und AKEMINE (1) berichteten über eine enge Beziehung zwischen der Wärme und dem Aufblühen. Hinsichtlich des Einflusses des Lichtes auf das Blütenöffnen gelangten NAKAO (15) und AKEMINE (1) zu entgegengesetzten Resultaten. Betreffs der Schädlichkeit des Windes, des Regens u. a. haben HECTOR (4), AKEMINE (1) und neuerdings auch LAUDE und STANSEL (13) einige Mitteilungen gemacht. Eine eingehende Studie über das in Rede stehende Thema fehlt aber bisher noch ganz.

Um diese Lücke auszufüllen war ich im Laufe der letzten sieben Jahren mit einer ziemlich ausführlichen Untersuchung über den Einfluss der Aussenbedingungen auf das Blütenöffnen von Reispflanzen beschäftigt, deren Ergebnisse schon teilweise veröffentlicht worden sind (9, 10, 11, 16, 17). Obschon meine diesbezügliche Untersuchungen keineswegs noch ganz fertig sind, doch sind sie in diesem Jahre zum gewissen Abschluss angekommen, so möchte ich hier alle bisher bekommenen Ergebnisse in der vorliegenden Mitteilung zusammenfassen.

Als Versuchsmaterial dienten mir die reinen Linien der Reissorten "Kumamoto" und "Goshiu," die seit alter Zeit im Garten der Tokyo kaiserl. Universität kultiviert wurden; die Hauptblühzeit der ersteren ist ungefähr Mitte August, während die der letztern Anfang Septembers ist.

# Temperatur

## 1. *Blühen im Freien*

Wenn man den Aufblühvorgang und die Temperaturschwankung

innerhalb eines Tages vergleicht, so kann man sehen, dass sie zueinander in einer engen Beziehung stehen.  In dieser Hinsicht habe ich in den Jahren 1922 und 1924 jeder Tag von 8 Uhr Vorm. bis 4 Uhr Nachm. stündlich die Zahl von sich öffnenden Blüten an gewissen Versuchspflanzen gerechnet und zugleich die derzeitigen Temperaturen im Häuschen in meinem Zuchtgarten beobachtet.  Das Resultat ist in Tab. 1–4 angegeben.[1]  Man wird daraus sehen, dass das Aufblühen innerhalb eines ziemlich weiten Spielraums der Temperatur stattfinden kann.  Ferner wird man daraus entnehmen, dass die Blüten um 8 Uhr Morgens zu öffnen beginnen, wobei die Temperatur schon etwa 27-28°C beträgt.  Unter niedrigerer Temperatur verzögert sich das Aufblühen, und je höher sie ist, desto lebhafter findet das Aufblühen statt, bis zu 32°C, wobei dieser Vorgang zu Stillstande kommen wird.[2]  Die Lufttemperatur bei der Blühzeit war etwas niedrig in Jahre 1924 (s. Tab. 3–4), da sogar um 9 Uhr Morgens sie selten auf 27°C gestiegen ist, aber die Blüten haben sich schon geöffnet, bevor noch die Temperatur 27°C nicht erreicht hatte.  Wenn es zu kühl war, verzögerte sich das Blütenöffnen im allgemeinen bis zur Zeit, wenn die Temperatur aufzusteigen beginnt; doch falls die andern Aussenbedingungen günstig sind, wurde es beobachtet, dass es sogar bei 25°C erfolgen kann.  Vielleicht ist die unmittelbare Wirkung der im Augenblick des Aufblühens herrschende Temperatur nicht, sondern die einige Zeit lang andauernde Wirkung der Morgentemperatur, die für das Geschehen dieses Vorganges entscheidend ist, wie schon AKEMINE (1) nachgewiesen hat.

Unten möchte ich noch weiter kurz betreffend die Temperatur in der Natur einige Berichte machen, wobei die Blüten des Reises sich öffnen.  Wie oben mitgeteilt, beträgt sie in Tokyo etwas 19–33°C. In Südjapan fand Iso (6) bei zwei Reissorten diese Temperatur etwa 28–33°C zu betragen, wärend AKEMINE (1) in Hokkaido, dem kälteren Gegend Japans, 8–32°C beobachtet hat.  Aus dem oben gesagten ist der Schluss berechtigt, dass wenn das Blühen im Freien etwa bei 10–35°C geschieht, diese Temperatur etwa von der Klima abhängig ist, da je südlicher der Gegend gelegen ist, desto höher muss die Temperatur dafür sein.

Als günstigst für das Aufblühen, wird ich die Temperatur annehmen, woran die Hauptblühzeit des Tages fällt.  Die Ergebnisse in

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(1) Alle Tabellen sind im am Ende der vorliegenden Abhandlung befindlichen Anhang zusammengestellt.
(2) Den 11. August haben ausnahmsweise wenige Blüten bei 33°C sich geöffnet.

vier Tabellen 1–4 und die der Beobachtungen im Jahre 1928 werden
in Tab. 5 zusammengestellt.   Wie aus diesen Resultaten ersichtlich
ist, geschieht das Aufblühen meistens bei 30°±2°C und diese Tem-
peratur kann somit als die günstigste betrachtet werden.

## 2.  *Optimum-Temperatur*

Nach AKEMINE (1) beträgt die Optimum-Temperatur für das
Blütenöffnen etwa 35–40°C und je höher die Temperatur in der
Natur ist, desto lebhafter erfolgt das Aufblühen.   Die folgende Ver-
suchsreihe wurde für die definitive Entscheidung dieser Tatsache
ausgeführt.

VERSUCH 1.   Bei der Reisrispe, die um die Hauptblühzeit ge-
rade aus der Blattscheide hervorzuragen beginnt, sieht man zunächst
einige geöffnete Blüten.   Meine Versuche waren wie folgt.   Sechs
in solchem Entwicklungstadium befindliche Rispen mit ziemlich langen
Halmen wurden in eine wasserhaltende Flasche gesteckt und in den
unter verschiedenen Temperaturen gehaltenen Thermostaten gestellt;
nach bestimmten Zeiten wurden die geöffneten Blüten daran gezählt.
Die Ergebnisse sind in Tab. 6 angegeben.   Hieraus ergibt es sich,
dass das Aufblühen sogar bei ziemlich hohen Temperaturen geschehen
kann, aber am lebhaftesten bei 30°C.   Die Temperatur, welche
niedriger ist als 25°C, ist nicht hoch genug, um die Blüten öffnen
zu lassen.

Bei meinen Versuchen fand ich häufig die kleistogamen Blüten
an den Rispen.   Bei Getreide haben einige Autoren[1] die gleichartige
Erscheinung unter niedriger Temperatur beobachtet, während OBER-
MAYER (20) sie bei Weizen, nicht nur unter niedriger, sondern auch
unter hoher Temperatur nachgewiesen hat.   Meinerseits habe ich
häufig solche Blüten bei hoher Temperatur gefunden, und zwar sogar
bei günstigster Temperatur 30°C.

VERSUCH 2.   Die Versuche sind fast in derselben Weise wie oben
angestellt, doch mit den Rispen, deren blütentragender Teil gerade
aus der Blattscheide herausgetreten ist.   Die Resultate sind in Tab. 7
zusammengefasst.   Das Aufblühen erfolgt am lebhaftesten bei 30°C,
und dazu folgen 28°, 25° und 35°C.   Wenn auch bei 55° und 60°C
das Aufblühen zu sehen war, sind dabei einige Rispen abgestorben;

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(1)   KÖRNICKE fand sie bei Weizen und Roggen, NOWACKI bei Gerste, GODRON
bei Weizen, Roggen und Gerste, RIMPAU bei Roggen, FRUWIRTH und HILDEBRAND
bei Hafer.

und man kann vielleicht sagen, dass die Temperatur ±50°C als die maximale Grenze des Aufblühens anzunehmen ist. Ich fand auch bei 20°C eine ziemlich grosse Zahl von sich öffnenden Blüten, und es ist klar, dass die minimale Temperatur noch niedriger liegen muss. Nach meinen Beobachtungen bei niedriger Temperatur geschah das Blühen langsam und die Hauptblühzeit kommt sehr spät zu. Diese Tatsache beobachteten schon KÖRNICKE (12), GODRON (3) und RIMPAU (21) bei Weizen und AKEMINE (1) bei Reis.

Aus allen oben erwähnten Untersuchungsresultaten sowohl aus den im Freien ausgeübten Beobachtungen komme ich zum definitiven Schlusse, dass die günstige Temperatur für das Aufblühen des Reises etwa 30°C beträgt.

### 3. *Bestäubung*

AKEMINE (1) hat schon die Tatsache nachgewiesen, dass die niedrige Temperatur das Platzen der Antheren verhindert. In den Tab. 8-9 habe ich die Resultate meiner Beobachtungen über den Einfluss der Temperatur auf das Platzen der Antheren und die nachfolgende Bestäubung hervorgehoben. Wie es daraus klar sein wird, erfolgen beide Vorgänge bei 25-35°C am besten und man kann etwa 30°C als die günstigste Temperatur für den Fruchtansatz betrachten.

### 4. *Spelzenwinkel*

Bei Getreide berichteten viele Forscher[1] die Tatsache, dass der Winkelgrad des Ausklappens der Spelzen beim Aufblühen unter ungünstigen Aussenbedingungen kleiner ist als in normalen Fällen. Ich habe den in Frage stehenden Winkel unter verschiedenen Temperaturen gemessen, deren Ergebnisse in Tab. 10 gegeben werden. Der Zeitpunkt, wobei das Maximum des Ausklappens liegt, ist keineswegs leicht bestimmbar, dennoch nahm ich aus meinen bisherigen Erfahrungen an, dass dies im wesentlichen dem Zeitpunkt entspricht, wenn die aus den Spelzen heraustretenden Staubfäden ihre grösste Länge erreichen. Die in Tab. 10 hervorgehobenen Ergebnisse weisen darauf hin, dass zwischen beiden keine enge Beziehung besteht und dass bei niedriger Temperatur der Winkelgrad sogar grösser sein kann.

---

(1) FRUWIRTH und RIMPAU bei Roggen, OBERMAYER, KÖRNICKE, NOWACKI und GODRON bei Weizen.

# Nässe

Seit lange hat man die Meinung vertreten, dass die bei der
Blühzeit von Reis herrschende Nässe den Fruchtansatz stark ver-
hindert. Dennoch hat niemand bisher eine nennenswerte Beziehung
zwischen der Nässe und dem Aufblühen gefunden, z. B. beobachte-
ten AKEMINE (1) und Iso (6) keinen besonderen Einfluss der Nässe
auf das Blühen von Reis.

## 1. *Aufblühen in der Natur*

Die Resultate meiner Beobachtungen in dieser Hinsicht im Jahre
1922 sind in Tab. 11-12 angegeben. Damals schwankte sich die
Feuchtigkeitsgrösse beträchtlich, da sie 58-90% (Tab. 11) bzw. 65-89%
(Tab. 12) betrug. Das Aufblühen erfolgte im allgemeinen am leb-
haftesten bei 70-80% Feuchtigkeit. Man kann daraus vielleicht
sagen, dass die 70-80% Feuchtigkeit für das Blühen am günstigsten
wirkt.

Lenkt man noch einmal sein Augenmerk auf Tab. 11, um die
Änderungsweise der Feuchtigkeitsverhältnisse vor der Hauptblühzeit
zu studieren, so wird die Tatsache besonders interessant sein, dass
jeder Morgen die Luftfeuchtigkeit plötzlich abnimmt, und die grosse
Anzahl der Blüten bald danach sich zu öffnen beginnen, wie man
aus Tab. 12 gut entnehmen kann. Im Jahre 1924 fand das Auf-
blühen innerhalb eines ziemlich weiten Spielraumes der Feuchtigkeit,
d. h. 49-94%, statt. Man kann vielleicht sagen, dass in diesem Falle
die günstige Feuchtigkeit ebenfalls etwa 70-80% beträgt und die
Hauptblühzeit der plötzlichen Veränderung derselben sofort nach-
folgt, wie in Tab. 13-14 gezeigt wird.

## 2. *Feuchtgesättigte Luft*

Um zu sehen, wie die mit Feuchtigkeit gesättigte Luft den
Blühvorgang beeinflussen wird, habe ich im Jahre 1924 die folgenden
Versuche gemacht: zehn gerade aus den Blattscheiden hervortretende
und annähernd gleich entwickelte Rispen wurden in einem Glaszy-
linder gelegt, dessen Inneres die mit Feuchtigkeit ganz gesättigte
Luft enthält. Als Kontrolle wurden eine gleiche Anzahl der Rispen
im ähnlichen Entwickelungsstadium im normalen Zustand zugelassen.
Die Ergebnisse waren wie in Tab. 15.

Aus der Vergleichung von beiden, konnte ich vor allem sehen, dass die hohe Luftfeuchtigkeit das Blütenöffnen etwas verhindert.

In den normalen Fällen beginnen die Reisblüten um 8–9 Uhr Morgens sich zu öffnen, dann nimmt das Aufblühen allmählich an Lebhaftigkeit zu, um schliesslich ein Maximum zu reichen, wonach es immer mehr absinkt. Die Kurve, die die Zahlenänderung des Blütenöffnens innerhalb eines Tages zeigt, ist ganz symmetrisch, wenn die Blütenzahl bei der Hauptblühzeit als der Mittelpunkt
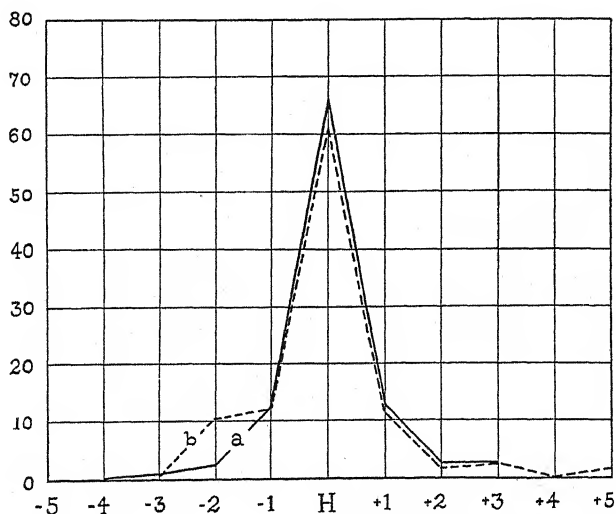


Fig. 1.  Ordinate=prozentige Zahl der geöffneten Blüten, Abszisse=Tagesstunde; Hauptblühzeit (H) als Mittelpunkt angenommen.  a. zeigt die Kurve im normalen Falle, und b. die in der gesättigtfeuchten Luft.

angenommen wird (Fig. 1, a). Die in ganz gleicher Weise gezeichnete Kurve des Blütenöffnens, das bei feuchtgesättigter Luft stattfindet, stimmt in ihrer Gestalt ganz mit derselben im normalen Fall überein (Fig. 1, b). Hieraus kann man den Schluss ziehen, dass die mit Feuchtigkeit ganz gesättigte Luft die Blühvorgangsweise nicht stören vermag.

### 3.  *Bestäubung und Kornbildung*

Am 13. August 1922 fand ich frühmorgens bei meinen Versuchspflanzen einige schon offenen Blüten, von denen die Antheren jedoch noch nicht geplatzt sind. Die Tatsache, dass die Antheren

erst einige Minuten nach dem Beginn des Öffnungsvorganges platzen,
ist schon von VAN DER STOK (3) in Java und RODRIGS (22) in den
Philippinen berichtet worden, Unter normalen Aussenbedingungen
beobachteten aber HECTOR (4), IKENO (5), AKEMINE (1) u. a. das
Erfolgen der Bestäubung von Reis, kurz vor oder zugleich mit dem
Öffnen. Meiner Ansicht nach, muss für die oben erwähnte abnorme
Erscheinung ein besonderes Verhältnis gewisser Aussenbedingungen
zu Grunde liegen und da die Temperatur, die damals etwa 28°C be-
trug, kein besonderes ist, möchte ich die Ursache davon in der Feuch-
tigkeit suchen, die damals etwa 90% zeigte.

Um genauer zu untersuchen, welchen Einfluss die Feuchtigkeit
auf das Blühen ausübt, habe ich es bei der ganz gesättigtfeuchten
Luft untersucht, und zwar mit besonderer Rücksicht auf das Platzen
der Antheren und die Bestäubung, obgleich Iso (6) schon eine kleine
Mitteilung über diese Erscheinung veröffentlicht hatte. Die Be-
obachtungsresultate lauten folgendermassen (Tab. 16).

Es ist klar, dass die grosse Nässe das Platzen der Antheren
verhindert, die oftmals gar nicht platzen können, was somit die
Bestäubung benachteiligt. Unter 46 geöffneten Blüten, welche von
mir untersucht wurden, haben 18 keine oder sehr wenige Pollen-
körner auf ihre Narben empfangen. Ich machte ferner über den
Einfluss der Feuchtigkeit auf den Fruchtansatz der Blüten einige
Versuche gemacht, deren Ergebnisse auf Tab. 17 angegeben sind.
Die Zahlenverhältnisse der wohlausgebildeten Körner zur Blütenzahl
beträgt bloss 58.6% und diese Kornbildung ist sehr schlecht zu be-
trachten, da sie im Freien 86.3% beträgt.

## Trockenheit

Als, wie oben angedeutet, die Feuchtigkeit, welche 70–80% be-
trägt, als die günstigste für das Aufblühen des Reises zu betrachten
ist, so muss man dieselbe, die niedriger ist, für diesen Vorgang zu
trocken ansehen. Ich möchte kurz meine Beobachtungen darüber
unten mitteilen.

### 1. *Aufblühen im Freien*

Aus Tab. 18 kann man sehen, dass das Aufblühen meistens bei
der Feuchtigkeit geschieht, welche höher als 65% ist, sehr selten
bei niedriger, doch niemals bei 49%. Daraus kann man schliessen,

dass die Trockenheit das Öffnen der Blüten verhindert und die minimale Feuchtigkeit dafür etwa 50% beträgt.

## 2.  *Einfluss der Trockenheit*

Um eine genaue Kenntnis des Einflusses der Trockenheit auf das Blühen zu bekommen, habe ich im Jahre 1924 die folgenden Versuche angestellt. Zehn gerade in Entfaltung begriffene Rispen wurden in einem Glaszylinder eingeschlossen, worin $CaCl_2$ eingelegt war. Eine gleiche Anzahl der Rispen wurden in normaler Weise zugelassen als Kontrolle. Die Ergebnisse sind in Tab. 19 angegeben. Man kann daraus vor allem sehen, dass das Aufblühen in trockner Luft ganz verhindert wird und dieser Vorgang darin abnormal geschieht, sodass die Zahl der geöffneten Blüten bei der Hauptblühzeit im Vergleich zu der Kontrolle sehr klein ist.

## 3.  *Bestäubung und Fruchtansatz*

Bei Gerste hat ENGLEDOW (2) die schädliche Wirkung der Trockenheit auf den Fruchtansatz studiert. Da auch bei Reis ich das gleiche erwartete, habe ich das Platzen der Antheren und die Bestäubung in trockner Luft untersucht. Tab. 20 zeigt klar, dass die Trockenheit gar keine benachteiligende Wirkung auf das Platzen der Antheren ausübt, da unter 73 Blüten ich nur 5 unbestäubte fand. Aus den obigen Zahlenverhältnissen könnte man dabei natürlich einen guten Fruchtansatz erwarten, was im Gegensatz zu den in Tab. 21 angegebenen Versuchsresultaten steht. Das Prozent der Kornbildung bei diesen Versuchen ist nämlich dabei viel kleiner als beim im Freien und dies ist der Schädigung der Narben durch Trockenheit zurückzuführen.

## 4.  *Trockenheit und Temperatur*

Um kennen zu lernen, wie Temperatur und Trockenheit auf das Blühen zusammenwirken, habe ich den Temperaturgrad notiert im Falle, wo das Blühen bei trockner Luft geschah. Unter 10 Fällen des Aufblühens fanden 8 bei 29–32°C und nur 2 bei niedriger als 27°C statt. Ich konnte nachweisen, dass die etwa 30°C betragende Lufttemperatur günstigst ist, um das Blütenöffnen bei trockner Luft zu veranlassen.

# Licht

Unter den gegenüber den Blüh- und Befruchtungsvorgängen der Pflanzen wirksamen Aussenbedingungen ist das Licht die neuerdings besonders mit Aufmerksamkeit studierte.[1] Die Tatsache, dass das Aufblühen der Weizen und Roggen beim schönen Wetter sich lebhaft vor sich geht, hat KÖRNICKE (12) zum Schlusse geführt, dass das starke Sonnenlicht das Aufblühen des Getreides im allgemeinen hemmen soll.   Niemand hat aber bisher über den Einfluss des Lichtes auf das Blühen von Reis etwaige Mitteilungen gemacht.[2]

## 1. *Direkter Einfluss*

In den Jahren 1924 und 1925 habe ich in dieser Beziehung einige Untersuchungen angestellt.  Zwanzig gerade aus den Blattscheiden hervortretende Rispen waren in doppelten Papiertüten eingeschlossen, welche innen schwarz und aussen weiss sind, und als Kontrolle wurde die gleiche Zahl von Rispen im ähnlichen Entwickelungsstadium im normalen Zustande zugelassen.  Jeder Tag von 8 Uhr Morgens bis 4 Uhr Abends wurden die sich öffnenden Blüten ausgezählt (Tab. 22–23).

Man kann an diesen Tabellen gleich sehen, dass das Blühen bei Dunkelheit sehr unregelmässig vorgeht, sodass die Hauptblühenzeit verspätet wird, und somit sogar nach 3 Uhr Nachmittags, wo das Blühen im Freien ganz aufhört, noch einige Blüten sich öffnen können.

Um die zahlenmässige Kenntnis des Blütenöffnens bei der Dunkelheit kennen zu lernen, habe ich in Tab. 24 die Zahl der geöffneten Blüten unter dem normalen und dunkelen Zustande angegeben.  Aus der Vergleichung von beiden, konnte ich vor allem sehen, dass bei der Dunkelheit das Blütenöffnen erheblich abnimmt.

Wenn man die Kurve des Blütenöffnens bei Dunkelheit, wobei die Hauptblühzeit für den Mittelpunkt genommen wird, mit der normalen vergleicht (Fig. 2, vgl. Fig. 1, S. 243), so kann man klar

---

(1) GARNER und ALLARD fand die beschleunigenden sowie verhindernden Wirkungen von Licht auf die Blütenentwickelung der Pflanzen.  Beim Reis habe ich neuerdings die gleichartige Tatsache nachgewiesen (18).

(2) Aus seinen Versuchen zieht AKEMINE (1) den Schluss, dass das Licht keine direkte Wirkung auf das Aufblühen ausübt.  Aber NAKAO (15) bemerkte den Einfluss des Lichtes, besonders des kurzwelligen.

sehen, dass die Dunkelheit nicht nur das Aufblühen stark stört, sondern auch den Blühvorgang unregelmässig macht, wobei die Hauptblühzeit etwa um einen Uhr verspätet wird als im Freien.

Weiter im Jahre 1928 habe ich die Experimente über die direkte Wirkung des Lichtes so angestellt, dass unter 12 gleichartig ent-
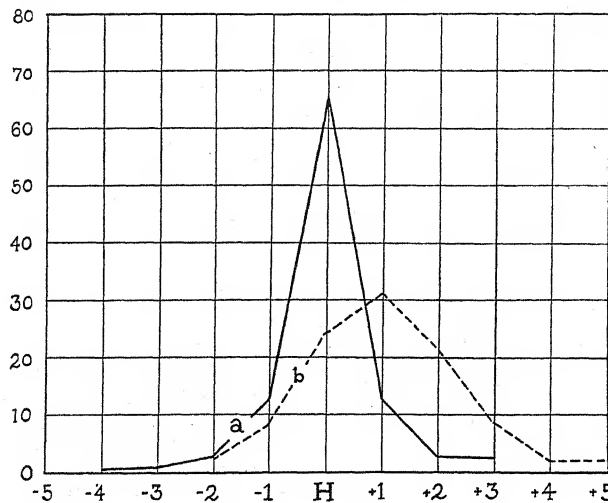
Fig. 2. Ordinate=prozentige Zahl der geöffneten Blüten, Abszisse=Tagesstunde; Hauptblühzeit (H) als Mittelpunkt angenommen. a. zeigt die Kurve im normalen Falle, und b. die in der Dunkelheit.

wickelten Rispen, ein Drittel bis 9 Uhr Morgens, das andere Drittel bis Mittag im Dunkelzimmer gehalten und die übrigen im normalen Zustande zugelassen wurden. Das Ergebnis auf Tab. 25 zeigt ohne Zweifel, dass das Licht das Blütenöffnen beschleunigt.[1]

## 2.   *Monochromatisches Licht*

Es wird von einigem Interesse sein zu studieren, welchen Einfluss das monochromatische Licht auf das Blühen ausübt. Wenn es viele Verfahren gibt, monochromatisches Licht zu bekommen, habe ich vor allem wegen der Einfachkeit und Bequemlichkeit gefärbte Paraffinpapiere benutzt, von denen die Wellenlänge des eindringenden Lichtes durch das Spektroskop untersucht wurde, wie man in Tab. 26 sieht.

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(1)   Über diese Erscheinung habe ich schon anderswo die Resultate meiner Untersuchung bei einer anderen Sorte von Reis veröffentlicht (**18**).

Im Jahre 1924-1925 habe ich so experimentiert, dass zwanzig gerade in der Entfaltung begriffene Rispen in verschiedengefärbten Papiertüten eingeschlossen sind, um dabei die Zahl der geöffneten Blüten und den Blühvorgang untereinander zu vergleichen. Keinen allzu grossen Unterschied fand ich zwischen der Blütenzahl bei jeder Farbe, aber sie war immer kleiner als im Freien und grösser als in der Dunkelheit (Tab. 27).

Die prozentige Zahl der sich öffnenden Blüten bei der Hauptblütenzeit bzw. bei einer Stunde vor und nach derselben in jedem Falle des für Versuche benutzten monochromatischen Lichtes wurde zueinander verglichen. In Hinsicht auf die Hauptblütezeit konnte ich zwischen ihnen bloss kleine Unterschiede nachweisen. Beim Blütenöffnen, die eine Stunde vor der Hauptblühzeit geschah, fand ich, dass die prozentige Zahl beim orange Licht am grössten ist und dass derselbe beim gelben folgt, was lehrt, dass das orange Licht am meisten das Blütenöffnen beschleunigt und das gelbe nächst kommt.

### 3. Ultraviolettes Licht

Neuerdings berichteten einige Forscher die Reizwirkung des ultravioletten Lichtes auf die Pflanzen. Ich habe in diesem Sommer (1928) eine kleine Untersuchung ausgeführt, um zu studieren, ob es das Blühen beschleunigen wird. Während gewissen Minuten wurde vor dem Blühen jede von fünf gleichartig entwickelten Rispen durch das in Rede stehende Licht beleuchtet und ihrer Blühvorgang wurde mit demselben der Kontrolle verglichen.

Das Ergebnis wird in Tab. 28 angegeben, woraus man schliessen kann, dass das ultraviolette Licht keineswegs auf das Blühen als Reiz wirken kann.

### 4. Elektrisches Licht

Je zwanzig Rispen, welche in Papiertüten eingeschlossen sind oder nicht, wurden über ganze Nacht durch etwa 200 W. elektrisches Licht beleuchtet. Tab. 29 zeigt die Anzahl der geöffneten Blüten bei diesem Versuche, woraus man sagen kann, dass das elektrische Licht den Blühvorgang erheblich beschleunigt.

### 5. Bestäubung und Fruchtansatz

Das Licht, das eine grosse Wirkung auf das Blühen ausübt, muss notwendigerweise auch auf die Bestäubung und den Frucht-

satz irgend einen Einfluss haben. Tab. 30 zeigt die Beziehung zwischen der Dunkelheit und dem Platzen der Antheren sowie dem Bestäubungsverhältnis. Unter 39 Blüten, die im Dunkeln geöffnet haben, sind nur 8 Blüten unbestäubt, von denen nur eine gestorbene Narben trägt. Ich habe in diesem Falle den guten Fruchtansatz erwartet und denselben der Blüten, die in dem Dunkel sich öffneten, mit demselben der im Freien verglichen. Die Ergebnisse sind in Tab. 31 angegeben.

Danach möchte ich den Schluss ziehen, dass die Dunkelheit das Antherenöffnen, die Bestäubung und den Fruchtansatz gar nicht beeinträchtigen kann.

## Luftdruck

In der Natur ist die Schwankung des Luftdruckes innerhalb eines Tages klein, sodass man keine nennenswerte Beziehung zwischen dem Luftdruck und dem Aufblühen des Reises erkennen kann, was auch AKEMINE (1) schon gesagt hatte. Um diese Tatsache zahlenmässig zu studieren, habe ich einige kleinen Versuche angestellt, deren Ergebnisse im folgenden mitgeteilt werden.

### Blühen im Freien

Um womöglich eine Beziehung zwischen dem Luftdruck und dem Aufblühen im Freien auszufinden, habe ich im letzten Sommer jede Stunde von 8 Uhr Vorm. bis 4 Uhr Nachm. die sich öffnenden Blüten an zehn Versuchspflanzen ausgezählt und dabei den damals herrschenden Luftdruck beobachtet. Das Resultat lautet wie folgt (Tab. 32).

Diese Tabelle zeigt das Blühen zur Zeit, wo der Luftdruck zwischen 747–761 schwankte; die Druckänderung innerhalb jedes Tages geht so langsam, dass er gar keinen Einfluss auf das Blühen ansübt.

Weiter habe ich den Luftdruck und die gesamte Zahl der Blüten, die in der Natur sich öffnen, jeder Tag vergleichweise studiert. Wenn man in Tab. 32 die in der letzten und vorletzten Kolumne angegebene Zahl zueinander vergleicht, so wird man sehen, dass die Zahl der sich öffnenden Blüten von der Änderung des Luftdruckes ganz unabhängig ist.

Um noch genauer die in Rede stehende Beziehung kennen zu lernen, wurden die folgenden Versuche angestellt. Jede von zehn eben im Aufblühen begriffenen Rispen wurde in einer grossen

Schale gelegt, wo verschiedene durch Wasserstrahlluftpumpe be-
wirkte Luftdrücke herrschen, und bei jeder wurde die Zahl der
geöffneten Blüten nach ungefähr 8 Stunden ausgezählt. Gar keiner
Unterschied wurde unter ihnen nachgewiesen. (Tab. 33–34).

# Regen und Sturm

Schon hat KÖRNICKE (12) bemerkt, dass Regen und Wind bei
der Blühzeit von Reis den Fruchtansatz beträchtlich beeinflussen.
Nach seinen Versuchsresultaten hat AKEMINE (1) die Meinung ge-
äussert, dass die Beeinträchtigung der Fruchtung durch Regen auf
das durch gesättigtfeuchte Luft veranlasste Verhindern des Anthe-
renplatzens, und die schädliche Wirkung des Sturms vielleicht nur
auf mechanische Ursache zurückzuführen ist. Beim Regen oder
Sturm wirken in der Natur zahlreiche Aussenfaktoren zusammen,
d. h. Temperatur, Feuchtigkeit u. a. und meiner Ansicht nach
müssen dabei die Wirkung einzelner Faktoren als solche einerseits
und ihre gesamte Wirkung anderseits unterschieden werden.

## 1. *Blühvorgang*

Das Verhindern des Blühens durch Regen wurde von KÖRNICKE
(12) bei Weizen und Roggen, von NOWACKI (19), GODRON (3) und
OBERMAYER (20) bei Weizen, und von FRUWIRTH (3) bei Hafer be-
obachtet. Nach OBERMAYER geschah es nur beim kalten Regen, und
kein Verhindern wird sogar beim Regen nicht bemerkt, wenn die
hohe Lufttemperatur dabei herrscht. HECTOR (4) hat dagegen beim
Regen kein Blütenöffnen von Reis beobachten können.

Um den Einfluss des Regens und Regensturmes auf das Blühen
von Reis kennen zu lernen, habe ich die Zahl der geöffneten Blüten
und den Blühvorgang bei regnerischem und schönem Wetter zuein-
ander verglichen. Die Ergebnisse in Tab. 35 sind aus solchen ver-
gleichenden Studien in den Jahren 1922 und 1924 entnommen.

Wie man in dieser Tab. sieht, an beiden Tagen, 15. August
1922 und 5. September 1924 regnete es sich vom Morgen bis zum
Abend unaufhörlich und doch ging das Aufblühen sehr lebhaft vor
sich. Eine einzige Ausnahme davon, wobei das Blütenöffnen stark
verhindert wurde, wird man in Tab. 35 (12. September, 1924) sehen.
Beim Tage, wo es zur Mittag unaufhörlich geregnet hat, war die
Zahl der geöffneten Blüten im Vergleich zu denselben beim vorigen

und auch beim nachfolgenden schönen Tage mittelmässig. Die genau gleiche Verhältnisse habe ich beim Regensturm in zwei Fälle nachgewiesen.

Hierauf scheint es mir wahrscheinlich zu sein, dass Regen oder Regensturm das Blühen nicht verhindert. An dieser Tab. kann man auch sehen, dass beim Regenstag der Blühvorgang sehr langsam vor sich geht und das Hauptblühen meistens bis zum Nachmittag sich verzögert.[1] Tab. 36 zeigt zahlenmässig die Resultate der Vergleichung des Blühvorganges beim regnerischen und schönen Wetter.

Die gleiche Erscheinung fand schon GODRON (3) bei Gerste und Weizen, RIMPAU (21) bei Weizen, OBERMAYER (20) bei Hafer, LAUDE und STANSEL (13) bei Reis. Im Falle, wo beim schwachen Regen das Blühen ziemlich lebhaft vor sich geht, fand ich nicht selten das langandauernde Offenbleiben der Blüten.

## 2.  *Temperatur und Feuchtigkeit*

Dass unter den das Blühen beeinflussenden Aussenbedingungen, Temperatur und Feuchtigkeit die grosse Rolle spielen, ist aus den oben erwähnten Ergebnissen leicht zu sehen. Für die Untersuchung des Blühens beim Regen oder Sturm müssen wir die Temperatur und die Feuchtigkeit beim regnerischen oder stürmischen Tage genau studieren. Tab. 37 zeigt solche. Die Temperatur beim regnerischen oder stürmischen Wetter war niedriger als beim schönen, auch war die Luft sehr nass, und beide erfahren nicht nenneswerte Veränderung durch den ganzen Tag. Trotzdem beide Temperatur und Feuchtigkeit für das Blühen sehr ungünstig waren, öffneten sich die Blüten ebenso lebhaft wie im normalen Fällen. Ungeachtet der AKEMINEs Annahme, dass das Anschlagen des Regens das Blütenöffnen des Reises nicht bewirken kann, scheint mir die Vermutung nahe zu sein, dass Regen und Sturm durch mechanische Reizung das Blütenöffnen bedingen können, was mit der Erfahrungen von V. TSCHERMAK (24) und KÖRNICKE (12) in Übereinstimmung steht, welche darin besteht, dass der Roggen infolge mechanischer Reizung seine Spelzen leicht öffnet, und dass der Hafer beim Regenguss seine Blüten plötzlich öffnet.

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(1)  Sie ist höchstwahrscheinlich auf das Zusammenwirken der niederen Temperatur, gesättigter Feuchtigkeit und des Lichtmangels zuzuschreiben.

### 3.  *Bestäubung und Kornbildung*

Beim Regen beobachtet man immer bei den geöffneten Reis-
blüten, dass die Staubfäden zuerst sich strecken, die nicht platzenden
Staubbeutel aussen den Spelzen hängen bleiben und die Narbe von
Regen geschlagen wird.  Man nimmt daher an, dass die Befruchtung
dabei verhindert werden soll.  Die mikroskopische Untersuchung der
Staubbeutel hat mir gezeigt, dass manche zerbrochen sind und dass
die Narbe, auf denen der Regentropfen hängen bleibt, einige Pollen-
körner trägt.  Um die Bestäubungsverhältnisse beim Regen kennen
zu lernen, habe ich die Anzahl des Pollens auf die Narben ausge-
rechnet.  Tab. 38 zeigt klar, dass die Bestäubung nicht ganz normal
vor sich geht.  Beim Regensturm sind manche Beutel sowie die
Narben durch die Wirkung von Wind und Regen verletzt.

Es fragt sich, ob die oben erwähnte Bestäubung beim Regen-
wetter den guten Fruchtansatz wirken kann.  Obgleich der Regen-
tropfen auf die Narbe hängt, können doch die Pollenkörner darauf
keimen und ihre Schläuche in der Griffel senden.  Aber das Kei-
mungsprozent der Pollenkörner ist sehr klein; um ein Beispiel zu
nennen habe ich unter 163 Pollenkörnern nur 3 keimende wahrge-
nommen.

Die Ergebnisse der Kornbildung stehen wie in Tab. 39.

Im Vergleich mit dem Fruchtansatz beim schönen Wetter,
welcher 86.3% beträgt, ist derselbe beim schlechten nicht so niedrig,
doch sind die unvollreifen Körner sehr zahlreich vertreten.

Wenn die Blüten von Getreide beim Regen sich öffnen, geht die
Bestäubung vor sich wie in normalen Fällen, aber da die Pollen-
körner keine Widerstandfähigkeit gegen Wasser haben, platzen sie
plötzlich und absterben, wie LIDFORSS (14) mitteilte.  Dennoch zeigen
die obigen Resultate, dass die Pollenkörner auf die wasserbedeckten
Narben keimen und die Eizelle befruchten können.  Wie STRAS-
BURGER (23) und JOST (7) nachgewiesen haben, ist die Narbe der
Getreidearten mit Kutikula bedeckt, so dass das Wasser darin nicht
eindringen kann.  Nach ELFVING, LIDFORSS (14), JOST (8) u. a. geht
die Keimung derartiger Pollenkörner im allgemeinen schnell vor sich.
Aus dieser Beobachtung kann ich die folgende wahrscheinliche An-
nahme machen, dass erst nach der Pollenkeimung das Öffnen der
Spelzen erfolgen soll; die Pollenschläuche dringen danach bald in die
Narben ein, welche durch Kutikula gegen Regen geschützt sind,
und die Befruchtung wird vollgezogen.  Diese Ansicht steht zu der

Meinung AKEMINES im Gegensatz, dass beim Regen der Fruchtansatz unmöglich ist, insoferne als die Beutel nicht platzen können.

### 4. *Spelzenwinkel*

Ich habe oben erwähnt, dass zwischen der Wärme und dem Winkelgrade des Ausklappens der Spelzen keine enge Beziehung besteht. Die Tatsache, dass bei Hafer dieser Winkel im Morgen und in der Abend klein ist, möchte FRUWIRTH (3) auf die hohe Feuchtigkeit im Freien zurückführen. Meine Beobachtungen haben mir gezeigt, dass der in Frage stehende Winkel soweit zur Feuchtigkeit in Beziehung steht, dass bei Regen oder Sturm er ein wenig klein ist. Die Ergebnisse meiner diesbetreffenden Messungen sind auf Tab. 40 angegeben.

Hierauf kann ich vielleicht sagen, dass der Öffnungswinkelgrad von beiden Spelzen beim schlechten wie beim schönen Wetter nicht besonders verschieden ist.

### Zusammenfassung

1. In der Natur erfolgt das Aufblühen von Reis, wenn die Temperatur um 8 Uhr Morgens schon etwa 27–28°C beträgt. Je höher die Temperatur, je lebhafter findet es statt bis zu 32°C, wobei dieser Vorgang zu Stillstande kommen wird.

2. Die günstigste Temperatur für das Blühen beträgt 30±2°C. Nach den Studien über die im Thermostat gehaltenen Rispen ist die Optimum-Temperatur für das Blütenöffnen ganz gleich wie im Freien. Die Temperatur 50°C wird die maximale Grenze des Aufblühens sein.

3. Das Platzen der Antheren und die Bestäubung finden am besten bei etwa 30°C statt. Der Öffnungswinkelgrad der Spelzen ist von der Temperatur ganz gleichgültig.

4. Die günstigste Feuchtigkeit für das Blühen beträgt 70–80% und die plötzlichen Veränderung derselben im Morgen wird bald vom Hauptblühen nachgefolgt. Die mit Feuchtigkeit ganz gesättigte Luft scheint das Blütenöffnen etwas zu verhindern.

5. Die grosse Nässe hemmt das Platzen der Antheren, die oftmals gar nicht platzen können, um somit die Bestäubung zu benachteiligen. Der Fruchtansatz der in solcher Umgebung entwickelten Rispen beträgt bloss 59% statt des normalen 86%.

6. Im Freien kann das Aufblühen sogar unter 50% Feuchtigkeit

stattfinden, doch schon unter 70% nimmt die Zahl der sich öffnenden Blüten bedeutend ab und unter 65% geschieht dieser Vorgang sehr selten. Die Optimum-Temperatur für diesen Vorgang beträgt 30°C, wenn die Luftfeuchtigkeit unter 70% ist.

7.  Weder das Platzen der Antheren noch die Bestäubung werden in der Trockenheit verhindert, doch wird der Fruchtansatz bedeutend herabgesetzt, was wahrscheinlich der Beschädigung bzw. dem Tod der Narben zu verdanken ist.

8.  Bei der Dunkelheit nimmt die Zahl der sich öffnenden Blüten erheblich ab und der Blühvorgang wird stark gestört, wobei die Hauptblühzeit etwa um einen Uhr verspätet wird. Das Antherenplatzen, die Bestäubung und der Fruchtansatz wurden dabei gar nicht beeinträchtigt.

9.  Unter dem monochromatischen Licht beschleunigt das orangefarbige das Blütenöffnen meistens, dann folgt das gelbe; das ultraviolette Licht wirkt nicht als Reiz auf das Blühen. Das elektrische Licht beschleunigt diesen Vorgang erheblich.

10.  Die Änderung des Luftdruckes in der Natur hat gar keinen Einfluss auf das Blühen von Reis.

11.  Die Gesamtzahl von sich öffnenden Blüten ist ganz gleich beim Regen und Sturm wie beim schönen Wetter, nur in ersteren Falle wird der Eintritt des Blühvorgangs um etwas 2-3 Uhr verspätet. Das Aufplatzen der Antheren und die Bestäubung beim schlechten Wetter werden etwas verhindert, doch wird der Fruchtansatz gar nicht beeinträchtigt.

12.  Beim regnerischen oder stürmischen Tage ist natürlich die Temperatur etwas niedriger als beim schönen Wetter und die Luft fast ganz feuchtgesättigt, was die Zahl der sich öffnenden Blüten bedeutend vermindern muss. Die Tatsache, dass trotzdem sie nicht besonders erniedrigt wird, ist nach meiner Ansicht darauf zurückzuführen, dass beide Regen und Wind durch mechanische Reizung das Blütenöffnen verursachen können.

Die in der vorliegenden Abhandlung erläuterte Arbeit wurde

teilweise durch die pekuniäre Unterstützung der Kaiserl. Akademie Japans ermöglicht, wofür ich auch hier meinen besten Dank abstatten möchte.

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# Anhang[1]

## TABELLE 1

### (Sorte "Kumamoto," 1922)

| | 8 Vm[2] | | 9 Vm | | 10 Vm | | 11 Vm | | Mittag | | 1 Nm[3] | | 2 Nm | | 3 Nm | | 4 Nm |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | T[4] | B[5] | T | B | T | B | T | B | T | B | T | B | T | B | T | B | T |
| 10. August | 27 | 0 | 28 | 1 | 29 | 1 | 31 | 17 | 32 | 9 | 33 | 0 | 33 | 0 | 33 | 0 | 32 |
| 11. ,, | 28 | 3 | 30 | 23 | 31 | 61 | 32 | 38 | 32 | 1 | 33 | 2 | 33 | 0 | 32 | 0 | 31 |
| 12. ,, | 29 | 5 | 29 | 81 | 31 | 101 | 32 | 7 | 32 | 2 | 33 | 0 | 31 | 0 | 31 | 0 | 28 |
| 13. ,, | 27 | 1 | 28 | 24 | 29 | 71 | 31 | 40 | 30 | 3 | 31 | 0 | 32 | 0 | 32 | 0 | 32 |
| 14. ,, | 27 | 0 | 27 | 5 | 28 | 76 | 29 | 48 | 29 | 6 | 29 | 0 | 29 | 0 | 30 | 2 | 31 |
| 16. ,, | 28 | 5 | 29 | 113 | 30 | 23 | 32 | 1 | 31 | 0 | 31 | 0 | 32 | 0 | 32 | 0 | 31 |
| 17. ,, | — | 1 | 29 | 1 | 29 | 134 | 31 | 9 | 31 | 0 | 32 | 0 | 32 | 0 | 31 | 3 | 30 |
| 18. ,, | — | 4 | 28 | 44 | 30 | 26 | 31 | 22 | 32 | 0 | 32 | 0 | 33 | 0 | 33 | 0 | 33 |
| 19. ,, | — | 0 | 29 | 16 | 30 | 76 | 31 | 8 | 32 | 1 | 33 | 0 | 33 | 0 | 33 | 0 | 32 |
| 20. ,, | — | 0 | 27 | 0 | 29 | 5 | 30 | 19 | 32 | 0 | 33 | 0 | 33 | 0 | 33 | 0 | 32 |
| 21. ,, | 28 | 0 | 29 | 19 | 30 | 60 | 32 | 6 | 32 | 0 | 33 | 0 | 33 | 0 | 33 | 0 | 32 |
| 22. ,, | — | 0 | 28 | 2 | 30 | 16 | 32 | 1 | 32 | 2 | 32 | 0 | 33 | 0 | 33 | 0 | 33 |
| 23. ,, | — | 1 | 29 | 11 | 29 | 3 | 30 | 1 | 31 | 0 | 31 | 0 | 31 | 0 | 29 | 0 | 29 |
| Mittel der Temperatur | 27.7 | | 28.5 | | 29.6 | | 31.1 | | 31.4 | | 32.0 | | 32.2 | | 31.9 | | 31.2 |
| Gesamte Blütenzahl | | 20 | | 340 | | 653 | | 217 | | 24 | | 2 | | 0 | | 5 | |

(1)  In allen Tabellen ist die Beobachtung an regnerischen Tagen nicht angegeben, ausgenommen in Tab. 35; z. B. in Tab. 1 wird deswegen 15. August ausgeschlossen.

(2)  Vm=Vormittag.

(3)  Nm=Nachmittag.

(4)  T=Temperatur.

(5)  B=Anzahl der offenen Blüten.

## TABELLE 2

### (Sorte "Goshiu, 1922)

| | 8 Vm | | 9 Vm | | 10 Vm | | 11 Vm | | Mittag | | 1 Nm | | 2 Nm | | 3 Nm | | 4 Nm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T | B | T | B | T | B | T | B | T | B | T | B | T | B | T | B | T |
| 28. August | — | 0 | 27 | 14 | 28 | 4 | 28 | 5 | 29 | 0 | 30 | 0 | 29 | 0 | 29 | 0 | 28 |
| 29. ,, | — | 0 | 26 | 10 | 27 | 16 | 28 | 20 | 29 | 0 | 29 | 0 | 29 | 0 | 30 | 1 | 30 |
| 30. ,, | — | 0 | 27 | 10 | 28 | 37 | 29 | 32 | 30 | 0 | 29 | 0 | 31 | 0 | 30 | 0 | 29 |
| 31. ,, | — | 0 | 27 | 58 | 29 | 24 | 29 | 74 | 29 | 16 | 31 | 0 | 31 | 0 | 28 | 0 | 28 |
| 1. Sept. | — | 0 | 26 | 35 | 29 | 43 | 29 | 145 | 31 | 8 | 31 | 0 | 32 | 0 | 31 | 0 | 30 |
| 2. ,, | — | 0 | 24 | 0 | 24 | 0 | 25 | 187 | 25 | 106 | 26 | 21 | 26 | 5 | 26 | 0 | 26 |
| 3. ,, | — | 0 | 27 | 14 | 28 | 272 | 28 | 24 | 29 | 0 | 29 | 0 | 29 | 0 | 29 | 0 | 29 |
| 4. ,, | — | 1 | 28 | 129 | 29 | 144 | 29 | 86 | 29 | 0 | 29 | 0 | 29 | 0 | 29 | 0 | 29 |
| 5. ,, | — | 1 | 29 | 6 | 30 | 325 | 31 | 73 | 31 | 0 | 31 | 0 | 31 | 0 | 31 | 0 | 31 |
| 6. ,, | — | 14 | 28 | 98 | 28 | 87 | 30 | 213 | 31 | 1 | 31 | 0 | 33 | 0 | 32 | 0 | 31 |
| 7. ,, | — | 0 | 27 | 0 | 28 | 165 | 30 | 94 | 31 | 16 | 30 | 0 | 31 | 0 | 30 | 0 | 30 |
| 8. ,, | — | 0 | 26 | 0 | 27 | 163 | 27 | 38 | 28 | 3 | 29 | 3 | 29 | 0 | 28 | 0 | 27 |
| 9. ,, | — | 0 | 23 | 0 | 24 | 28 | 24 | 8 | 25 | 43 | 25 | 0 | 26 | 0 | 27 | 0 | 27 |
| 10. ,, | — | 0 | 26 | 0 | 27 | 17 | 28 | 17 | 29 | 0 | 29 | 0 | 30 | 0 | 30 | 0 | 29 |
| 11. ,, | — | 0 | — | 1 | 28 | 3 | 30 | 3 | 31 | 0 | 31 | 0 | 31 | 0 | 31 | 0 | 31 |
| Mittel der Temperatur | — | | 26.5 | | 27.6 | | 28.3 | | 29.1 | | 29.3 | | 29.8 | | 29.3 | | 28.7 |
| Gesamte Blütenzahl | | 16 | | 375 | | 1328 | | 1019 | | 193 | | 24 | | 5 | | 1 | |

## TABELLE 3

### (Sorte "Kumamoto," 1924)

| | 8 Vm | | 9 Vm | | 10 Vm | | 11 Vm | | Mittag | | 1 Nm | | 2 Nm | | 3 Nm | | 4 Nm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T | B | T | B | T | B | T | B | T | B | T | B | T | B | T | B | T |
| 14. August | 27 | 0 | 28 | 0 | 29 | 1 | 30 | 1 | 31 | 0 | 31 | 0 | 32 | 0 | 32 | 0 | 31 |
| 15.     ,, | 27 | 0 | 27 | 28 | 27 | 5 | 27 | 9 | 27 | 5 | 27 | 6 | 27 | 3 | 26 | 0 | 26 |
| 16.     ,, | 22 | 0 | 24 | 0 | 26 | 2 | 26 | 53 | 27 | 43 | 26 | 1 | 26 | 0 | 26 | 0 | 26 |
| 17.     ,, | 23 | 0 | 24 | 4 | 26 | 10 | 27 | 201 | 27 | 30 | 27 | 6 | 27 | 0 | 27 | 0 | 27 |
| 18.     ,, | 23 | 0 | 24 | 2 | 25 | 2 | 26 | 150 | 25 | 158 | 27 | 3 | 25 | 0 | 26 | 3 | 26 |
| 20.     ,, | 27 | 423 | 28 | 34 | 29 | 43 | 29 | 10 | 31 | 0 | 30 | 0 | 31 | 0 | 31 | 0 | 31 |
| 21.     ,, | 27 | 0 | 28 | 51 | 29 | 406 | 30 | 57 | 31 | 9 | 31 | 1 | 31 | 0 | 31 | 0 | 30 |
| 23.     ,, | 27 | 4 | 29 | 258 | 31 | 27 | 32 | 1 | 32 | 0 | 32 | 0 | 33 | 0 | 33 | 0 | 33 |
| 24.     ,, | 24 | 0 | 27 | 31 | 28 | 297 | 29 | 98 | 30 | 7 | 30 | 14 | 31 | 3 | 32 | 0 | 30 |
| Mittel der Temperatur | 25.2 | | 26.6 | | 27.8 | | 28.4 | | 29.0 | | 29.0 | | 29.2 | | 29.3 | | 28.9 |
| Gesamte Blütenzahl | | 427 | | 408 | | 793 | | 580 | | 252 | | 31 | | 6 | | 3 | |

## TABELLE 4

### (Sorte "Goshiu," 1924)

| | 8 Vm | | 9 Vm | | 10 Vm | | 11 Vm | | Mittag | | 1 Nm | | 2 Nm | | 3 Nm | | 4 Nm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T | B | T | B | T | B | T | B | T | B | T | B | T | B | T | B | T |
| 3. Sept. | 26 | 0 | 27 | 0 | 28 | 1 | 28 | 2 | 29 | 12 | 29 | 0 | 29 | 0 | 28 | 0 | 28 |
| 4.    ,, | 24 | 0 | 26 | 2 | 27 | 44 | 27 | 80 | 28 | 95 | 28 | 9 | 28 | 2 | 28 | 0 | 28 |
| 7.    ,, | 19 | 2 | 21 | 30 | 23 | 126 | 25 | 116 | 25 | 28 | 24 | 7 | 26 | 11 | 27 | 1 | 27 |
| 8.    ,, | 21 | 0 | 23 | 15 | 24 | 152 | 26 | 319 | 27 | 176 | 28 | 21 | 28 | 0 | 29 | 0 | 28 |
| 9.    ,, | 24 | 2 | 26 | 148 | 28 | 207 | 28 | 296 | 29 | 58 | 29 | 3 | 29 | 7 | 29 | 0 | 29 |
| 10.    ,, | 24 | 0 | 24 | 57 | 25 | 175 | 26 | 233 | 26 | 283 | 27 | 6 | 27 | 58 | 27 | 0 | 27 |
| 11.    ,, | 21 | 0 | 22 | 0 | 23 | 124 | 23 | 341 | 26 | 444 | 26 | 96 | 27 | 11 | 27 | 1 | 27 |
| 13.    ,, | 22 | 0 | 24 | 18 | 25 | 319 | 27 | 296 | 27 | 84 | 27 | 7 | 28 | 4 | 28 | 3 | 27 |
| 15.    ,, | 19 | 0 | 19 | 0 | 20 | 0 | 21 | 0 | 20 | 0 | 20 | 0 | 20 | 20 | 20 | 26 | 19 |
| Mittel der Temperatur | 22.2 | | 23.6 | | 24.8 | | 25.7 | | 26.3 | | 26.3 | | 26.9 | | 27.0 | | 26.7 |
| Gesamte Blütenzahl | | 4 | | 270 | | 1148 | | 1683 | | 1180 | | 149 | | 113 | | 31 | |

## TABELLE  5

|  | Temperatur der Hauptblühzeit (C) | | | |
|---|---|---|---|---|
|  | Niedriger als 25° | 25°—28° | 28°—32° | Höher als 32° |
| 1922 | 0 | 4 | 24 | 0 |
| 1924 | 1 | 10 | 7 | 0 |
| 1928 | 0 | 5 | 10 | 0 |
| Summe | 1 | 19 | 41 | 0 |

## TABELLE  6

| Temperatur (C) | Anzahl der geöffneten Blüten | | | | | | | | Summe | Anzahl der kleistogamen Blüten |
|---|---|---|---|---|---|---|---|---|---|---|
|  | Nach 5 Min. | Nach 10 Min. | Nach 20 Min. | Nach 30 Min. | Nach 1 St. | Nach 2 St. | Nach 3 St. | Nach 5 St. |  |  |
| 55°(1) | 3 | 3 | 4 | 2 | — | — | — | — | 12 | 54 |
| 50° | 2 | 4 | 3 | 3 | 2 | — | — | — | 14 | 83 |
| 45° | 8 | 11 | 6 | 1 | — | — | — | — | 26 | 47 |
| 40° | 10 | 6 | 5 | 3 | 1 | 3 | — | — | 28 | 8 |
| 35° | 12 | 8 | 3 | 4 | — | 5 | — | — | 32 | 12 |
| 30° | 20 | 15 | 5 | 5 | 5 | 1 | — | — | 51 | 4 |
| 28° | 7 | 4 | 4 | 4 | 3 | 1 | — | — | 23 | 4 |
| 25° | — | — | — | — | — | — | — | — | — | 4 |
| 20° | — | — | — | — | — | — | — | — | — | 4 |

(1)   Bei 50° und 60° waren einige Rispen nach einer Stunde abgestorben.

## TABELLE   7

| Temperatur (C) | Anzahl der geöffneten Blüten | | | | | | |
|---|---|---|---|---|---|---|---|
| | Nach 1 St. | Nach 2 St. | Nach 3 St. | Nach 4 St. | Nach 5 St. | Nach 6 St. | Summe |
| 60°[1] | 8 | — | — | — | — | — | 8 |
| 55°[1] | 179 | 21 | 3 | 1 | — | — | 204 |
| 50° | 179 | 31 | 5 | — | — | — | 215 |
| 45° | 105 | 64 | 24 | — | — | — | 193 |
| 40° | 123 | 21 | 15 | 1 | — | — | 160 |
| 35° | 272 | 86 | 9 | — | — | — | 367 |
| 30° | 378 | 129 | 15 | 4 | — | — | 526 |
| 28° | 365 | 90 | 28 | 4 | — | — | 487 |
| 25° | 174 | 68 | 72 | 92 | 7 | — | 413 |
| 20° | 10 | 33 | 111 | 38 | 6 | — | 198 |

## TABELLE   8

| Zahl der geplatzten Antheren | Anzahl der geöffneten Blüten | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Mittel |
| Temperatur (C) 55° | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5.00 |
| 50° | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 0.75 |
| 45° | 3 | 0 | 1 | 3 | 3 | 1 | 14 | 1.52 |
| 40° | 9 | 3 | 4 | 4 | 6 | 8 | 8 | 2.79 |
| 35° | 21 | 4 | 2 | 1 | 3 | 3 | 2 | 4.61 |
| 30° | 25 | 3 | 1 | 0 | 1 | 0 | 3 | 5.18 |
| 25° | 21 | 6 | 0 | 2 | 0 | 1 | 0 | 5.43 |
| 20° | 2 | 1 | 1 | 1 | 2 | 2 | 0 | 2.33 |

(1)   Bei 55° und 60° waren einige Rispen nach einer Stunde abgestorben.

### TABELLE 9

| Temperatur (C) | Anzahl der geöffneten Blüten | | |
|:---:|:---:|:---:|:---:|
| | Mit Pollen auf Narben | Ohne Pollen auf Narben | Summe |
| 55° | 1 | 0 | 1 |
| 50° | 1 | 3 | 4 |
| 45° | 9 | 16 | 25 |
| 40° | 22 | 20 | 42 |
| 35° | 25 | 10 | 35 |
| 30° | 26 | 7 | 33 |
| 25° | 26 | 4 | 30 |
| 20° | 7 | 2 | 9 |

### TABELLE 10

| Sorte | Winkelgrad der Spelzen | | | | | |
|:---:|:---:|:---:|:---:|:---:|:---:|:---:|
| | Kumamoto | | | Goshiu | | |
| | Mittel | Max. | Min. | Mittel | Max. | Min. |
| 60° | — | — | — | — | — | -- |
| 55° | — | — | — | 23.9±0.9 | 28.5 | 18.0 |
| 50° | 16.0 | — | — | 20.9±0.6 | 27.0 | 16.0 |
| 45° | 24.9±0.8 | 27.0 | 23.0 | 22.1±1.0 | 30.0 | 17.0 |
| 40° | 20.8±0.5 | 25.0 | 18.0 | 20.1±0.8 | 28.0 | 15.0 |
| 35° | 20.0±0.7 | 24.5 | 17.5 | 23.3±0.6 | 29.0 | 18.0 |
| 30° | 18.3±0.4 | 19.0 | 17.0 | 25.1±0.9 | 31.0 | 17.0 |
| 25° | 21.6±0.6 | 25.0 | 17.0 | 25.5±1.0 | 28·0 | 22.0 |
| 20° | 24.0±1.5 | 26.0 | 20.5 | 27.5±1.4 | 30.0 | 22.0 |

## TABELLE   11

### (Sorte "Kumamoto," 1922)

| | 8 Vm | | 9 Vm | | 10 Vm | | 11 Vm | | Mittag | | 1 Nm | | 2 Nm | | 3 Nm | | 4 Nm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F[1] | B | F | B | F | B | F | B | F | B | F | B | F | B | F | B | F |
| 10. August | 84 | 0 | 85 | 1 | 73 | 1 | 77 | 17 | 66 | 9 | 78 | 0 | 67 | 0 | 66 | 0 | 74 |
| 11. ,, | 85 | 3 | 81 | 23 | 77 | 61 | 73 | 38 | 74 | 1 | 74 | 2 | 74 | 0 | 77 | 0 | 81 |
| 12. ,, | 85 | 5 | 90 | 81 | 81 | 101 | 77 | 7 | 77 | 2 | 70 | 0 | 77 | 0 | 81 | 0 | 80 |
| 13. ,, | 84 | 1 | 90 | 24 | 85 | 71 | 77 | 40 | 77 | 3 | 73 | 0 | 77 | 0 | 74 | 0 | 77 |
| 14. ,. | 84 | 0 | 84 | 5 | 85 | 76 | 81 | 48 | 85 | 6 | 81 | 0 | 76 | 2 | 81 | 0 | 77 |
| 16. ,, | 90 | 5 | 81 | 113 | 81 | 23 | 85 | 1 | 81 | 0 | 81 | 0 | 77 | 0 | 82 | 0 | 81 |
| 17. ,, | — | 1 | 81 | 1 | 81 | 134 | 77 | 9 | 69 | 0 | 77 | 0 | 77 | 3 | 81 | 0 | 85 |
| 18. ,, | — | 4 | 85 | 44 | 77 | 26 | 81 | 22 | 77 | 0 | 82 | 0 | 74 | 0 | 70 | 0 | 70 |
| 19. ,, | — | 0 | 81 | 16 | 77 | 76 | 77 | 8 | 77 | 1 | 74 | 0 | 74 | 0 | 74 | 0 | 74 |
| 20. ,, | — | 0 | 90 | 0 | 81 | 5 | 73 | 19 | 66 | 0 | 66 | 0 | 66 | 0 | 63 | 0 | 69 |
| 21. ,, | 85 | 0 | 73 | 19 | 73 | 60 | 69 | 6 | 66 | 0 | 63 | 0 | 63 | 0 | 59 | 0 | 62 |
| 22. ,, | — | 0 | 80 | 2 | 68 | 16 | 58 | 1 | 58 | 2 | 62 | 0 | 59 | 0 | 62 | 0 | 59 |
| 23. ,, | — | 1 | 81 | 11 | 85 | 3 | 77 | 1 | 77 | 0 | 77 | 0 | 73 | 0 | 76 | 0 | 81 |
| Mittel der Feuchtigkeit | 85.3 | | 83.2 | | 78.8 | | 75.5 | | 73.1 | | 73.7 | 0 | 71.9 | 0 | 72.8 | | 74.6 |
| Differenz | | 2.1 | | 4.4 | | 3.3 | | 2.4 | | —0.6 | | 1.8 | | —0.9 | | —1.8 | |
| Gesamte Blütenzahl | | 20 | | 340 | | 653 | | 217 | | 24 | | 2 | | 5 | | 0 | |

(1)   F=Feuchtigkeit (%).

## TABELLE   12

### (Sorte "Goshiu," 1922)

| | 8 Vm | | 9 Vm | | 10 Vm | | 11 Vm | | Mittag | | 1 Nm | | 2 Nm | | 3 Nm | | 4 Nm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | B | F | B | F | B | F | B | F | B | F | B | F | B | F | B | F |
| 28. August | -- | 0 | 84 | 14 | 76 | 4 | 76 | 5 | 76 | 0 | 68 | 0 | 68 | 0 | 68 | 0 | 72 |
| 29.   ,, | — | 0 | 89 | 10 | 75 | 16 | 80 | 20 | 73 | 0 | 68 | 0 | 68 | 0 | 68 | 1 | 65 |
| 30.   ,, | — | 0 | 80 | 10 | 72 | 37 | 68 | 32 | 68 | 0 | 72 | 0 | 65 | 0 | 68 | 0 | 73 |
| 31.   ,, | — | 0 | 80 | 58 | 76 | 24 | 76 | 74 | 68 | 16 | 69 | 0 | 65 | 0 | 76 | 0 | 72 |
| 1. Sept. | — | 0 | 68 | 35 | 76 | 43 | 73 | 145 | 65 | 8 | 69 | 0 | 62 | 0 | 65 | 0 | 73 |
| 2.   ,, | — | 0 | 89 | 0 | 89 | 0 | 89 | 187 | 89 | 106 | 84 | 21 | 84 | 5 | 80 | 0 | 84 |
| 3.   ,, | — | 0 | 84 | 14 | 76 | 272 | 72 | 24 | 72 | 0 | 73 | 0 | 73 | 0 | 68 | 0 | 68 |
| 4.   ,, | — | 1 | 76 | 129 | 76 | 144 | 76 | 86 | 76 | 0 | 73 | 0 | 76 | 0 | 73 | 0 | 76 |
| 5.   ,, | — | 1 | 85 | 6 | 77 | 325 | 73 | 73 | 77 | 0 | 69 | 0 | 77 | 0 | 73 | 0 | 77 |
| 6.   ,, | — | 14 | 85 | 98 | 80 | 87 | 77 | 213 | 77 | 1 | 73 | 0 | 63 | 0 | 66 | 0 | 66 |
| 7.   ,, | — | 0 | 84 | 0 | 80 | 165 | 73 | 94 | 73 | 16 | 73 | 0 | 69 | 0 | 68 | 0 | 81 |
| 8.   ,, | — | 0 | 84 | 0 | 80 | 163 | 80 | 38 | 72 | 3 | 76 | 3 | 76 | 0 | 85 | 0 | 94 |
| 9.   ,, | — | 0 | 94 | 0 | 94 | 28 | 89 | 8 | 89 | 43 | 89 | 0 | 84 | 0 | 71 | 0 | 75 |
| 10.   ,, | — | 0 | 90 | 0 | 90 | 17 | 85 | 17 | 81 | 0 | 76 | 0 | 73 | 0 | 77 | 0 | 81 |
| 11.   ,, | — | 0 | — | 1 | 80 | 3 | 77 | 3 | 73 | 0 | 66 | 0 | 73 | 0 | 73 | 0 | 77 |
| Mittel der Feuchtigkeit | — | | 83.7 | | 79.8 | | 77.6 | | 75.3 | | 73.2 | | 71.7 | 0 | 71.9 | | 75.6 |
| Differenz | — | | 3.9 | | 2.2 | | 2.3 | | 2.1 | | 1.5 | | -0.2 | | -3.7 | | |
| Gesamte Blütenzahl | | 16 | | 375 | | 1328 | | 1019 | | 193 | | 24 | | 5 | | 1 | |

## TABELLE   13
### (Sorte "Kumamoto," 1924)

| | 8 Vm | | 9 Vm | | 10 Vm | | 11 Vm | | Mittag | | 1 Nm | | 2 Nm | | 3 Nm | | 4 Nm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | B | F | B | F | B | F | B | F | B | F | B | F | B | F | B | F |
| 14. August | 81 | 0 | 81 | 0 | 74 | 1 | 70 | 1 | 71 | 0 | 74 | 0 | 64 | 0 | 68 | 0 | 68 |
| 15.    ,, | 85 | 0 | 76 | 28 | 76 | 5 | 76 | 9 | 76 | 5 | 76 | 6 | 73 | 3 | 76 | 0 | 72 |
| 16.    ,, | 79 | 0 | 75 | 0 | 72 | 2 | 76 | 53 | 73 | 43 | 68 | 1 | 76 | 0 | 72 | 0 | 76 |
| 17.    ,, | 89 | 0 | 84 | 4 | 76 | 10 | 76 | 201 | 81 | 30 | 73 | 6 | 69 | 0 | 73 | 0 | 62 |
| 18.    ,, | 89 | 0 | 84 | 2 | 80 | 2 | 80 | 150 | 84 | 158 | 85 | 3 | 94 | 0 | 90 | 3 | 85 |
| 20.    ,, | 85 | 423 | 85 | 34 | 81 | 43 | 77 | 10 | 74 | 0 | 78 | 0 | 67 | 0 | 70 | 0 | 70 |
| 21.    ,, | 85 | 0 | 85 | 51 | 82 | 406 | 74 | 57 | 74 | 9 | 70 | 1 | 70 | 0 | 70 | 0 | 70 |
| 23.    ,, | 62 | 4 | 57 | 258 | 50 | 27 | 49 | 1 | 45 | 0 | 47 | 0 | 45 | 0 | 47 | 0 | 59 |
| 24.    ,, | 72 | 0 | 85 | 31 | 63 | 297 | 60 | 98 | 58 | 7 | 60 | 14 | 55 | 3 | 59 | 0 | 58 |
| Mittel der Feuchtigkeit | 80.8 | | 79.1 | | 72.7 | | 70.9 | | 70.7 | | 70.1 | | 68.1 | | 69.5 | | 68.9 |
| Differenz | | 1.7 | | 6.4 | | 1.8 | | 0.2 | | 0.6 | | 2.0 | | −1.4 | | 0.6 | |
| Gesamte Blütenzahl | | 427 | | 408 | | 793 | | 580 | | 252 | | 31 | | 6 | | 3 | |

## TABELLE   14
### (Sorte "Goshiu," 1924)

| | 8 Vm | | 9 Vm | | 10 Vm | | 11 Vm | | Mittag | | 1 Nm | | 2 Nm | | 3 Nm | | 4 Nm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | B | F | B | F | B | F | B | F | B | F | B | F | B | F | B | F |
| 3. Sept. | 84 | 0 | 85 | 0 | 73 | 1 | 73 | 2 | 70 | 12 | 70 | 0 | 70 | 0 | 73 | 0 | 69 |
| 4.    ,, | 89 | 0 | 85 | 2 | 85 | 44 | 81 | 80 | 77 | 95 | 81 | 9 | 77 | 2 | 77 | 0 | 77 |
| 7.    ,, | 88 | 2 | 89 | 30 | 75 | 126 | 61 | 116 | 61 | 28 | 72 | 7 | 58 | 11 | 62 | 1 | 73 |
| 8.    ,, | 83 | 0 | 79 | 15 | 80 | 152 | 80 | 319 | 77 | 176 | 77 | 21 | 77 | 0 | 74 | 0 | 77 |
| 9.    ,, | 84 | 2 | 90 | 148 | 81 | 207 | 81 | 296 | 74 | 58 | 74 | 3 | 74 | 7 | 74 | 0 | 74 |
| 10.    ,, | 80 | 0 | 72 | 57 | 68 | 175 | 58 | 233 | 65 | 283 | 56 | 6 | 56 | 58 | 62 | 0 | 59 |
| 11.    ,, | 94 | 0 | 83 | 0 | 84 | 124 | 84 | 341 | 80 | 444 | 80 | 96 | 73 | 11 | 76 | 1 | 73 |
| 13.    ,, | 89 | 0 | 94 | 18 | 94 | 319 | 81 | 296 | 81 | 84 | 81 | 7 | 73 | 4 | 73 | 3 | 77 |
| 15.    ,, | 82 | 0 | 82 | 0 | 83 | 0 | 70 | 0 | 78 | 0 | 78 | 0 | 78 | 20 | 78 | 26 | 78 |
| Mittel der Feuchtigkeit | 85.9 | | 84.3 | | 80.3 | | 74.3 | | 73.7 | | 74.3 | | 70.7 | | 72.1 | | 73.0 |
| Differenz | | 1·6 | | 4.0 | | 6.0 | | 0.6 | | −0.6 | | 3.6 | | −1.4 | | 0.9 | |
| Gesamte Blütenzahl | | 4 | | 270 | | 1148 | | 1683 | | 1180 | | 149 | | 113 | | 31 | |

Y. NOGUCHI

## TABELLE 15

Anzahl der geöffneten Blüten

| | Kontrolle | | | | | | | | | Eingeschlossen | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8-9 Vm | 9-10 | 10-11 | 11-Mittag | Mittag-1 Nm | 1-2 | 2-3 | 3-4 | Sum. | 8-9 Vm | 9-10 | 10-11 | 11-Mittag | Mittag-1 Nm | 1-2 | 2-3 | 3-4 | Sum. |
| 16. August | 1 | — | 1 | 11 | 2 | 2 | — | — | 17 | — | — | — | — | — | — | — | — | 0 |
| 17. ,, | — | 8 | — | 24 | 12 | — | 2 | — | 46 | — | — | 8 | 2 | — | — | — | — | 10 |
| 18. ,, | — | — | 18 | 48 | 9 | — | — | — | 75 | — | 7 | 12 | 8 | 11 | — | — | — | 38 |
| 19. ,, | — | — | 5 | 110 | 17 | 1 | — | — | 133 | — | 1 | 1 | 35 | — | — | — | — | 37 |
| 20. ,, | 24 | 19 | 7 | 2 | — | — | — | — | 52 | 32 | 7 | 4 | — | — | — | — | — | 43 |
| 21. ,, | — | 27 | 30 | — | — | — | — | — | 57 | 9 | 6 | 38 | 4 | — | — | — | — | 57 |
| 22. ,, | — | 4 | 6 | 9 | 50 | 8 | 3 | 2 | 82 | — | 1 | 2 | 2 | 43 | 8 | — | — | 56 |
| 23. ,, | — | 25 | 3 | — | 1 | — | — | — | 29 | 6 | 16 | 9 | — | — | — | — | — | 31 |
| 24. ,, | — | — | 8 | 8 | — | — | — | 6 | 16 | — | 3 | 11 | 28 | — | — | — | — | 42 |
| 25. ,, | — | — | — | 1 | 30 | — | 2 | — | 39 | — | — | 1 | — | 9 | — | 1 | 8 | 19 |
| 26. ,, | — | — | — | 1 | 2 | — | — | — | 3 | — | 9 | — | 0 | — | — | — | 4 | 13 |
| Summe | | | | | | | | | 549 | | | | | | | | | 346 |

## TABELLE 16

| Zahl der geplatzten Antheren | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Mittel |
|---|---|---|---|---|---|---|---|---|
| Blütenzahl | 15 | 11 | 9 | 14 | 18 | 13 | 33 | **2.41** |

## TABELLE 17

| Rispen | Gesamte Körner | Vollreife Körner | Taube Körner |
|---|---|---|---|
| I | 66 | 59 | 7 |
| II | 57 | 34 | 23 |
| III | 42 | 2 | 40 |
| IV | 61 | 44 | 17 |
| V | 54 | 25 | 29 |
| Summe | 280 | **164 (=58.6%)** | 116 |

## TABELLE 18

| | 8 Vm | | 9 Vm | | 10 Vm | | 11 Vm | | Mittag | | 1 Nm | | 2 Nm | | 3 Nm | | 4 Nm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | B | F | B | F | B | F | B | F | B | F | B | F | B | F | B | F |
| 10. August, 1922 | 84 | 0 | 85 | 1 | 73 | 1 | 77 | 17 | 66 | 9 | 78 | 0 | 67 | 0 | 66 | 0 | 74 |
| 20.      ,, | — | 0 | 90 | 0 | 81 | 5 | 73 | 19 | 66 | 0 | 66 | 0 | 66 | 0 | 63 | 0 | 69 |
| 21.      ,, | 85 | 0 | 73 | 19 | 73 | 60 | 69 | 6 | 66 | 0 | 63 | 0 | 63 | 0 | 59 | 0 | 62 |
| 22.      ,, | — | 0 | 80 | 2 | 68 | 16 | 58 | 1 | 58 | 2 | 62 | 0 | 59 | 0 | 62 | 0 | 59 |
| 30.      ,, | — | 0 | 80 | 10 | 72 | 37 | 68 | 32 | 68 | 0 | 72 | 0 | 65 | 0 | 68 | 0 | 73 |
| 31.      ,, | — | 0 | 80 | 58 | 76 | 24 | 76 | 74 | 68 | 16 | 69 | 0 | 65 | 0 | 76 | 0 | 72 |
| 1. Sept., 1922 | — | 0 | 68 | 35 | 76 | 43 | 73 | 145 | 65 | 8 | 69 | 0 | 62 | 0 | 65 | 0 | 73 |
| 16. August, 1924 | 79 | 0 | 75 | 0 | 72 | 2 | 76 | 53 | 73 | 43 | 68 | 1 | 76 | 0 | 72 | 0 | 76 |
| 17.      ,, | 89 | 0 | 84 | 4 | 76 | 10 | 76 | 201 | 81 | 30 | 73 | 6 | 69 | 0 | 73 | 0 | 62 |
| 23.      ,, | 62 | 4 | 57 | 258 | 50 | 27 | 49 | 1 | 45 | 0 | 47 | 0 | 45 | 0 | 47 | 0 | 59 |
| 24.      ,, | 72 | 0 | 85 | 31 | 63 | 297 | 60 | 98 | 58 | 7 | 60 | 14 | 55 | 3 | 59 | 0 | 58 |
| 7. Sept., 1924 | 88 | 2 | 89 | 30 | 75 | 126 | 61 | 116 | 61 | 28 | 72 | 7 | 58 | 11 | 62 | 1 | 73 |
| 10.      ,, | 80 | 0 | 72 | 57 | 68 | 175 | 58 | 233 | 65 | 283 | 56 | 6 | 56 | 58 | 62 | 0 | 59 |

## TABELLE 19

| | Anzahl der sich öffnenden Blüten | | | | | | | | | | | | | | | | |
| | Kontrolle | | | | | | | | Eingeschlossen | | | | | | | | |
| | 8-9 Vm | 9-10 | 10-11 | 11-Mittag | Mittag-1 Nm | 1-2 | 2-3 | 3-4 | Sum. | 8-9 Vm | 9-10 | 10-11 | 11-Mittag | Mittag-1 Nm | 1-2 | 2-3 | 3-4 | Sum. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17. August | – | – | 17 | 41 | 4 | – | – | – | 62 | – | – | – | 9 | – | 1 | – | – | 10 |
| 18. ,, | – | – | 5 | 28 | 11 | 1 | – | – | 45 | – | – | 4 | 8 | 4 | – | – | – | 16 |
| 19. ,, | – | – | – | 82 | 6 | – | – | – | 88 | – | 1 | 7 | 21 | 8 | – | – | – | 37 |
| 20. ,, | 24 | 19 | 7 | 2 | – | – | – | – | 52 | 8 | 29 | 1 | – | – | – | – | – | 38 |
| 21. ,, | – | 27 | 30 | – | – | – | – | – | 57 | – | 11 | 24 | 7 | – | – | – | – | 42 |
| 22. ,, | – | 4 | 6 | 9 | 50 | 8 | 3 | 2 | 82 | 4 | 23 | 3 | – | 23 | 3 | 3 | – | 59 |
| 23. ,, | – | 25 | 3 | – | 1 | – | – | – | 29 | 5 | 10 | 17 | 2 | – | – | – | – | 34 |
| 24. ,, | – | – | 8 | 8 | – | – | – | – | 16 | – | 1 | 4 | 0 | – | – | – | – | 5 |
| 25. ,, | – | – | – | 1 | 30 | – | 2 | 6 | 39 | – | – | – | – | 2 | 3 | – | 3 | 8 |
| Summe | | | | | | | | | 470 | | | | | | | | | 249 |

## TABELLE 20

| Zahl der geplatzten Antheren | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Mittel |
|---|---|---|---|---|---|---|---|---|
| Blütenzahl | 47 | 9 | 2 | 2 | 1 | 2 | 0 | 5.48 |

## TABELLE 21

| | Zahl der Rispen | Gesamte Körner | Vollreife Körner | Taube Körner | Prozent der Kornbildung |
|---|---|---|---|---|---|
| Kontrolle | 8 | 596 | 541 | 55 | 90.4 |
| Eingeschlossen | 6 | 262 | 168 | 94 | 64.1 |

## TABELLE   22

### (Sorte " Kumamoto ")

| | Anzahl der sich öffnenden Blüten | | | | | | | | | | | | | | | | | |
| | Kontrolle | | | | | | | | | Eingeschlossen | | | | | | | | |
| | 8-9 Vm | 9-10 | 10-11 | 11-Mit. | Mit.-1 Nm | 1-2 | 2-3 | 3-4 | Sum. | 8-9 Vm | 9-10 | 10-11 | 11-Mit. | Mit.-1 Nm | 1-2 | 2-3 | 3-4 | Sum. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13. August, 1924 | — | — | 1 | 2 | 1 | 1 | — | — | 5 | — | — | — | — | — | — | — | — | — |
| 14.     ,, | 1 | — | — | 9 | 1 | 1 | — | — | 12 | — | — | — | — | — | — | — | — | — |
| 15.     ,, | — | 8 | — | 24 | 12 | — | 2 | — | 46 | — | — | — | — | — | — | — | — | — |
| 16.     ,, | — | — | 1 | 7 | 5 | — | — | — | 13 | — | — | — | — | — | — | — | — | — |
| 17.     ,, | — | — | 17 | 41 | 4 | — | — | — | 62 | — | — | — | — | — | — | — | — | — |
| 18.     ,, | — | — | 5 | 28 | 11 | 1 | — | — | 45 | — | — | — | — | — | — | — | — | — |
| 19.     ,, | — | — | — | 82 | 6 | — | — | — | 88 | — | — | — | — | — | — | — | — | — |
| 20.     ,, | 24 | 19 | 7 | 2 | — | — | — | — | 52 | 12 | — | — | 10 | — | 3 | — | — | 25 |
| 21.     ,, | — | 27 | 30 | — | — | — | — | — | 57 | — | 10 | 20 | 102 | 13 | 10 | 3 | — | 158 |
| 22.     ,, | — | 4 | 6 | 9 | 50 | 8 | 3 | 2 | 82 | — | — | 10 | 17 | 42 | 17 | 34 | 20 | 140 |
| 23.     ,, | — | 25 | 3 | — | 1 | — | — | — | 29 | 32 | 11 | 32 | 22 | — | — | — | — | 97 |
| 24.     ,, | — | — | 8 | 8 | — | — | — | — | 16 | — | — | 8 | 13 | 18 | 28 | 2 | — | 69 |
| 25.     ,, | — | — | — | 1 | 30 | — | 2 | 6 | 39 | — | — | 2 | — | 1 | — | — | — | 3 |
| 26.     ,, | — | — | — | 1 | — | — | — | 2 | 3 | — | — | 2 | 1 | — | — | 2 | 6 | 11 |
| 20. August, 1925 | — | — | 10 | 11 | 1 | — | — | — | 22 | — | — | — | — | — | — | — | — | — |
| 21.     ,, | 22 | 10 | 30 | 3 | — | — | — | — | 65 | 4 | 5 | 23 | 21 | 13 | 3 | — | — | 69 |
| 22.     ,, | 1 | 8 | 54 | 17 | — | — | — | — | 80 | 1 | 1 | 19 | 27 | 6 | 4 | 4 | — | 62 |
| 23.     ,, | — | 5 | 46 | 25 | 4 | — | — | — | 80 | — | 1 | 11 | 11 | 25 | 15 | — | — | 63 |
| 24.     ,, | 3 | 26 | 20 | 25 | — | — | — | — | 74 | — | 0 | 2 | 20 | 4 | 3 | 2 | — | 31 |
| 27.     ,, | — | 8 | 6 | — | — | — | — | — | 14 | — | 0 | 37 | 2 | — | — | — | — | 39 |
| 28.     ,, | 5 | 12 | 50 | 32 | — | — | — | — | 99 | — | 3 | 26 | 22 | 2 | 4 | — | — | 57 |
| 29.     ,, | — | 1 | 93 | 23 | 4 | — | — | — | 121 | — | 2 | 20 | 52 | — | — | — | — | 74 |
| 30.     ,, | — | — | 87 | 2 | — | — | — | — | 89 | — | — | 37 | 7 | — | — | — | — | 44 |

## TABELLE 23

### (Sorte " Goshiu ")

| | | Anzahl der sich öffnenden Blüten | | | | | | | | | | | | | | | | |
| | | Kontrolle | | | | | | | | Eingeschlossen | | | | | | | | |
| | | 8-9 Vm | 9-10 | 10-11 | 11-Mit. | Mit.-1 Nm | 1-2 | 2-3 | 3-4 | Sum. | 8-9 Vm | 9-10 | 10-11 | 11-Mit. | Mit.-1 Nm | 1-2 | 2-3 | 3-4 | Sum. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5. | September, 1924 | — | — | — | — | 7 | 5 | — | — | 12 | — | — | — | — | 1 | — | — | — | 1 |
| 6. | ,, | — | — | — | — | — | — | 29 | 1 | 30 | — | — | — | — | — | — | 1 | — | 1 |
| 7. | ,, | — | — | 30 | 15 | 8 | — | 1 | — | 54 | — | — | 6 | 8 | 10 | 6 | 5 | 16 | 51 |
| 8. | ,, | — | — | 56 | 85 | 7 | 4 | — | — | 152 | — | — | 2 | 3 | 36 | 37 | 11 | — | 89 |
| 9. | ,, | — | 5 | 3 | — | 1 | — | — | — | 9 | — | — | — | 38 | 6 | 20 | 7 | 1 | 72 |
| 10. | ,, | — | — | 6 | 2 | 32 | — | — | — | 40 | — | 0 | — | — | 17 | 71 | 22 | 16 | 126 |
| 11. | ,, | — | — | — | 58 | 31 | 4 | 1 | — | 94 | — | — | — | 0 | 5 | — | — | — | 5 |
| 12. | ,, | — | — | — | — | 45 | 55 | 10 | 9 | 119 | — | — | — | — | — | — | — | — | — |
| 13. | ,, | — | 1 | 21 | 49 | 20 | — | — | — | 91 | — | — | 11 | 28 | 9 | — | 1 | — | 49 |
| 14. | ,, | — | — | — | — | — | 16 | 89 | 7 | 112 | — | — | — | — | — | — | 0 | 7 | 7 |
| 7. | September, 1925 | — | 8 | 28 | 2 | — | — | — | — | 38 | — | 18 | 19 | 3 | — | — | — | — | 40 |
| 8. | ,, | — | 7 | 50 | 31 | 5 | 1 | — | — | 94 | 26 | 29 | 14 | 10 | 2 | 1 | — | — | 82 |
| 9. | ,, | — | — | 1 | 4 | 65 | 36 | — | — | 106 | — | — | — | 8 | 8 | 17 | 35 | — | 68 |
| 11. | ,, | — | — | 29 | 6 | 1 | — | 2 | — | 38 | — | — | 28 | 5 | 1 | — | 1 | 1 | 36 |
| 12. | ,, | 1 | 3 | 30 | 29 | — | — | — | — | 63 | 1 | 29 | 17 | 4 | — | — | — | — | 51 |
| 13. | ,, | — | — | — | 2 | 52 | 23 | 2 | — | 79 | — | — | — | 1 | 3 | 3 | 20 | 1 | 28 |
| 14. | ,, | — | 3 | 16 | 1 | — | — | — | — | 20 | — | 4 | 14 | 12 | 4 | — | — | — | 34 |
| 15. | ,, | — | 9 | 76 | 12 | — | — | — | — | 97 | — | — | 0 | 14 | 16 | 11 | 3 | 1 | 45 |
| 16. | ,, | — | 3 | 8 | 43 | 11 | 4 | — | — | 69 | — | — | — | 26 | 42 | 36 | 7 | — | 111 |

TABELLE   24

| | | 1924 | 1925 | Summe | |
|---|---|---|---|---|---|
| Sorte | Kontrolle | 549 | 644 | **1193** | 100.0 |
| "Kumamoto" | Eingeschlossen | 503 | 439 | **942** | 79.0 |
| Sorte | Kontrolle | 713 | 604 | **1317** | 100.0 |
| "Goshiu" | Eingeschlossen | 401 | 495 | **896** | 68.0 |

TABELLE   25

| | Anzahl der geöffneten Blüten | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 8–9 Vm | 9–10 | 10–11 | 11–Mittag | Mittag–1 Nm | 1–2 | 2–3 | 3–4 | 4–5 |
| Kontrolle | — | 5 | 103 | 106 | 16 | 8 | — | — | — |
| Bis 9 Uhr dunkelgehalten | — | — | 10 | 97 | 30 | 17 | — | — | — |
| Bis Mittag dunkelgehalten | — | — | — | — | 27 | 60 | 55 | 1 | — |

TABELLE   26

| | Rot | Orange | Gelb | Grün | Blau | Purpur |
|---|---|---|---|---|---|---|
| Wellenlänge (μμ) | 700-660 | 660–600 | 600–530 | 530–500 | 500–420 | 440–350 |

TABELLE   27

| | Anzahl der geöffneten Blüten | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Rot | Orange | Gelb | Grün | Blau | Purpur | Im Freien | Im Dunkeln |
| Sorte "Kumamoto" | 980 | 1006 | 1044 | 961 | 1065 | 990 | 1193 | 942 |
| Sorte "Goshiu" | 1169 | 1022 | 1251 | 983 | 1156 | 1176 | 1317 | 896 |

## TABELLE 28

| | Anzahl der geöffneten Blüten | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 8–9 Vm | 9–10 | 10–11 | 11–Mittag | Mittag– 1 Nm | 1–2 | 2–3 | 3–4 | Summe |
| Kontrolle | — | 1 | 25 | 181 | 48 | 1 | — | — | 256 |
| Behandelt 10 Minuten | — | 4 | 18 | 98 | 80 | 9 | — | — | 209 |
| ,,      20    ,, | — | — | 32 | 109 | 55 | 13 | — | — | 209 |
| ,,      30    ,, | — | 3 | 26 | 112 | 103 | 29 | 2 | — | 275 |

## TABELLE 29

| Sorte "Kumamoto" | | | Sorte "Goshiu" | | |
|---|---|---|---|---|---|
| | Zahl d. geöffn. Blüten bei elekt. L. | Zahl d. geöffn. Blüten im Dunkeln | | Zahl d. geöffn. Blüten bei elekt. L. | Zahl d. geöffn. Blüten im Dunkeln |
| 19. Aug., 1924 | 0 | 0 | 9. Sept., 1924 | 4 | 1 |
| 20.     ,, | 0 | 0 | 10.     ,, | 0 | 1 |
| 21.     ,, | 38 | 0 | 11.     ,, | 16 | 10 |
| 22.     ,, | 24 | 1 | 12.     ,, | 85 | 8 |
| 23.     ,, | 13 | 0 | 13.     ,, | 111 | 42 |
| 24.     ,, | 7 | 0 | 14.     ,, | 74 | 11 |
| 25.     ,, | 8 | 17 | 15.     ,, | 52 | 13 |
| 26.     ,, | 3 | 3 | 16.     ,, | 96 | 11 |
| | | | 17.     ,, | 113 | 28 |
| | | | 18.     ,, | 30 | 1 |
| Summe | 93 | 21 | | 581 | 126 |

## TABELLE 30

| Zahl d. geplatzten Antheren | 0 | 1 | 2 | 3 | 4 | 5 | 6 | Mittel |
|---|---|---|---|---|---|---|---|---|
| Zahl d. geöffneten Blüten | 0 | 1 | 0 | 1 | 1 | 4 | 47 | **5.74** |

## TABELLE 31

| | | Zahl der Rispen | Gesamte Körner | Reife Körner | | Taube Körner | Kornbild- ungs- prozent |
|---|---|---|---|---|---|---|---|
| | | | | Voll | Schlecht | | |
| Sorte | Kontrolle | 8 | 596 | 507 | 34 | 55 | **90.8** |
| "Kumamoto" | Eingeschlossen | 7 | 408 | 299 | 60 | 49 | 88.0 |
| Sorte | Kontrolle | 8 | 463 | 370 | 40 | 63 | 88.6 |
| "Goshiu" | Eingeschlossen | 6 | 375 | 305 | 40 | 30 | 92.0 |

## TABELLE 32

(Sorten, "Kumamoto" und "Goshiu")

| | 8 Vm | | 9 Vm | | 10 Vm | | 11 Vm | | Mittag | | 1 Nm | | 2 Nm | | 3 Nm | | 4 Nm | | Mittle der | Gesamte |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | D (1) | B (2) | D | B | D | B | D | B | D | B | D | B | D | B | D | B | D | B | Liftdruck | Blütenzahl |
| 17. August, 1928 | 755 | 0 | 756 | 0 | 756 | 7 | 756 | 104 | 756 | 135 | 756 | 29 | 756 | 3 | 755 | 1 | 755 | 0 | 756 | 279 |
| 18. ,, | 755 | 0 | 755 | 0 | 755 | 5 | 755 | 124 | 754 | 332 | 754 | 93 | 754 | 13 | 754 | 11 | 754 | 0 | 754 | 578 |
| 19. ,, | 753 | 0 | 753 | 0 | 753 | 0 | 752 | 15 | 752 | 54 | 752 | 223 | 752 | 219 | 751 | 182 | 751 | 21 | 752 | 713 |
| 20. ,, | 747 | 0 | 747 | 0 | 747 | 0 | 747 | 2 | 747 | 15 | 747 | 684 | 747 | 44 | 747 | 7 | 747 | 0 | 747 | 752 |
| 21. ,, | 751 | 0 | 751 | 9 | 751 | 91 | 751 | 536 | 751 | 157 | 751 | 8 | 751 | 0 | 751 | 0 | 751 | 0 | 751 | 801 |
| 22. ,, | 755 | 0 | 755 | 0 | 755 | 162 | 755 | 180 | 755 | 453 | 755 | 143 | 755 | 30 | 754 | 0 | 754 | 0 | 755 | 978 |
| 23. ,, | 756 | 0 | 756 | 0 | 756 | 3 | 756 | 68 | 756 | 171 | 756 | 630 | 756 | 65 | 755 | 1 | 755 | 0 | 756 | 938 |
| 24. ,, | 757 | 0 | 757 | 0 | 757 | 0 | 757 | 1 | 757 | 9 | 758 | 156 | 757 | 238 | 757 | 365 | 757 | 55 | 757 | 824 |
| 25. ,, | 757 | 0 | 757 | 0 | 757 | 1 | 757 | 5 | 756 | 43 | 756 | 123 | 756 | 109 | 756 | 14 | 756 | 0 | 756 | 295 |
| 26. ,, | 756 | 0 | 757 | 0 | 756 | 3 | 757 | 81 | 757 | 220 | 757 | 82 | 757 | 2 | 757 | 0 | 755 | 0 | 757 | 388 |
| 27. ,, | 759 | 0 | 759 | 0 | 759 | 1 | 759 | 14 | 759 | 69 | 759 | 214 | 759 | 3 | 759 | 0 | 759 | 0 | 759 | 301 |
| 28. ,, | 760 | 0 | 761 | 0 | 761 | 1 | 761 | 0 | 761 | 147 | 760 | 19 | 760 | 0 | 760 | 0 | 759 | 0 | 760 | 167 |
| 4. September, 1928 | 759 | 0 | 760 | 0 | 760 | 24 | 760 | 274 | 760 | 432 | 760 | 21 | 760 | 0 | 760 | 0 | 759 | 0 | 659 | 751 |
| 5. ,, | 759 | 0 | 760 | 9 | 760 | 36 | 759 | 909 | 759 | 188 | 759 | 1 | 759 | 0 | 759 | 0 | 759 | 0 | 759 | 1143 |
| 6. ,, | 759 | 0 | 759 | 0 | 759 | 0 | 759 | 839 | 759 | 410 | 759 | 8 | 759 | 0 | 759 | 0 | 759 | 0 | 759 | 1257 |
| 7. ,, | 760 | 0 | 760 | 0 | 760 | 0 | 760 | 261 | 706 | 1094 | 760 | 132 | 760 | 0 | 759 | 0 | 759 | 0 | 759 | 1487 |
| 8. ,, | 759 | 0 | 759 | 0 | 759 | 52 | 759 | 416 | 758 | 631 | 758 | 0 | 758 | 0 | 758 | 0 | 758 | 0 | 758 | 1099 |

(1) D = Luftdruck.
(2) B = Anzahl der geöffneten Blüten.

## TABELLE 33

| Luftdruck (m.m.) | 760 | 750 | 740 | 730 | 720 |
|---|---|---|---|---|---|
| Zahl der geöffneten Blüten | 126 | 119 | 111 | 114 | 205 |

## TABELLE 34

| Luftdruck (m.m.) | 750 | 760 | 770 | 780 |
|---|---|---|---|---|
| Zahl der geöffneten Blüten | 245 | 253 | 278 | 265 |

## TABELLE 35

| | Regens-dauer | Anzahl der geöffneten Blüten | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 8-9 Vm. | 9-10 | 10-11 | 11-Mit. | Mit.-1 Nm. | 1-2 | 2-3 | 3-4 | Summe |
| 14. Aug., 1922 | | 0 | 5 | 76 | 48 | 6 | 0 | 2 | 0 | 137 |
| 15. ,, | Ganz. Tag | 0 | 39 | 124 | 14 | 5 | 0 | 0 | 0 | 182 |
| 16. ,, | | 5 | 113 | 23 | 1 | 0 | 0 | 0 | 0 | 142 |
| 18. Aug., 1924 | | 0 | 2 | 2 | 150 | 158 | 3 | 0 | 3 | 318 |
| 19. ,, | Vormittag | 1 | 2 | 6 | 367 | 53 | 8 | 4 | 0 | 441 |
| 20. ,, | | 423 | 34 | 43 | 10 | 0 | 0 | 0 | 0 | 510 |
| 4. Sept., 1924 | | 0 | 2 | 44 | 80 | 95 | 9 | 2 | 0 | 232 |
| 5. ,, | Ganz. Tag | 0 | 0 | 0 | 1 | 176 | 188 | 0 | 0 | 365 |
| 6. ,, | Vormittag | 0 | 0 | 1 | 0 | 4 | 6 | 202 | 64 | 277 |
| 7. ,, | | 2 | 30 | 126 | 116 | 28 | 7 | 11 | 1 | 321 |
| 11. Sept., 1924 | | 0 | 0 | 124 | 341 | 444 | 96 | 11 | 1 | 1017 |
| 12. ,, | Ganz. Tag | 0 | 0 | 0 | 0 | 25 | 375 | 31 | 9 | 440 |
| 13. ,, | | 0 | 18 | 319 | 296 | 84 | 7 | 4 | 3 | 731 |
| 14. ,, | Vormittag | 0 | 0 | 1 | 0 | 14 | 413 | 144 | 100 | 672 |
| 15. ,, | | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 26 | 46 |
| 21. Aug., 1924 | | 0 | 51 | 406 | 57 | 9 | 1 | 0 | 0 | 524 |
| 22. ,, | Vormittag (stürmisch) | 26 | 61 | 60 | 58 | 221 | 39 | 12 | 0 | 477 |
| 23. ,, | | 4 | 258 | 27 | 1 | 0 | 0 | 0 | 0 | 290 |
| 24. ,, | | 0 | 31 | 297 | 98 | 7 | 14 | 3 | 0 | 450 |
| 25. ,, | Vormittag (stürmisch) | 0 | 2 | 7 | 1 | 53 | 0 | 8 | 64 | 135 |
| 26. ,, | | 1 | 0 | 0 | 9 | 7 | | 1 | 3 | 21 |

## TABELLE   36

| Sorte | Wetter | Anzahl der geöffneten Blüten | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 8–9 Vm | 9–10 | 10–11 | 11-Mit. | Mit.-1 Nm | 1–2 | 2–3 | 3–4 |
| "Kumamoto" | Schön[1] | 447 | 748 | **1346** | 797 | 281 | 33 | 12 | 3 |
| | Regen | 1 | 69 | 135 | **390** | 63 | 14 | 7 | 0 |
| | Sturm | 26 | 63 | 67 | 59 | 274 | 39 | 20 | 64 |
| "Goshiu" | Schön[2] | 20 | 645 | 2476 | 2702 | 1373 | 173 | 118 | 32 |
| | Regen | 0 | 0 | 2 | 1 | 219 | 982 | 377 | 173 |

(1)   Beobachtung während 22 Tage.
(2)   Beobachtung während 24 Tage.

## TABELLE   37

| | Regen | | | | | | | | | | | | Sturm | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15. Aug., 1922 | | 19. Aug., 1924 | | 5. Sept., 1924 | | 6. Sept., 1924 | | 12. Sept., 1924 | | 14. Sept., 1924 | | 22. Aug., 1924 | | 25. Aug., 1924 | |
| | T[1] | F[2] | T | F | T | F | T | F | T | F | T | F | T | F | T | F |
| 8   Vm | — | — | 24 | 94 | 23 | 100 | 21 | 100 | 24 | 84 | 22 | 89 | 27 | 85 | 25 | 84 |
| 9   ,, | 28 | 94 | 24 | 94 | 23 | 100 | 22 | 94 | 24 | 94 | 22 | 89 | 26 | 85 | 25 | 90 |
| 10   ,, | 28 | 90 | 24 | 100 | 24 | 89 | 21 | 94 | 23 | 100 | 23 | 89 | 26 | 85 | 23 | 94 |
| 11   ,, | 28 | 85 | 26 | 94 | 24 | 89 | 21 | 94 | 24 | 89 | 22 | 89 | 26 | 85 | 24 | 94 |
| Mittag | 30 | 85 | 26 | 94 | 24 | 94 | 21 | 94 | 24 | 89 | 22 | 89 | 26 | 90 | 24 | 100 |
| 1   Nm | 29 | 85 | 27 | 90 | 24 | 94 | 21 | 94 | 24 | 89 | 23 | 84 | 27 | 85 | 25 | 90 |
| 2   ,, | 31 | 85 | 27 | 90 | 25 | 90 | 22 | 94 | 24 | 94 | 22 | 84 | 27 | 85 | 26 | 80 |
| 3   ,, | 30 | 85 | 28 | 90 | 25 | 90 | 21 | 87 | 24 | 94 | 24 | 80 | 28 | 81 | 27 | 69 |
| 4   ,, | 29 | 85 | 27 | 90 | 24 | 94 | 21 | 94 | 24 | 94 | 23 | 84 | 28 | 81 | 26 | 76 |
| Vergleichung mit der Temp. beim schönen Tage | Keine Verschied. | | 3-4° Niedrig | | 2-3° Niedrig | | 3-4° Niedrig | | Keine Verschied. | | 2° Niedrig | | 3-4° Niedrig | | 3-4° Niedrig | |

(1)   T=Temperatur.
(2)   F=Feuchtigkeit (%).

TABELLE  38

| Gestorbene Narben | Kein Pollen auf Narben | Wenig Pollen auf Narben | Reiche Bestäubung |
|---|---|---|---|
| 7 | 7 | 17 | 58 |

TABELLE  39

| Wetter | Nr. d. Rispen | Blütenzahl | Gute Körner | Schlechter Kornansatz | Taube Körner | Kornbildungs- prozent |
|---|---|---|---|---|---|---|
| Regen | 10 | 169 | 124 | 13 | 32 | 81.1 |
| Sturm | — | 31 | 13 | 16 | 2 | 93.5 |

TABELLE  40

| Sorte | | "Kumamoto" | | | "Goshiu" | |
|---|---|---|---|---|---|---|
| Wetter | | Schön | Regen | Sturm | Schön | Regen |
| Winkelgrad der Spelzen | Mittel. | 18.5±0.6 | 18.6±0.8 | 17.7±0.8 | 22.8±0.4 | 22.2±0.3 |
| | Max. | 34.0 | 30.0 | 23.0 | 33.0 | 30.0 |
| | Min. | 10.0 | 9.0 | 12.0 | 14.0 | 14.0 |

# Interspecific Hybridization in *Brassica*

## II. The Cytology of $F_1$ Hybrids of *B. cernua* and various other Species with 10 Chromosomes

By Toshitaro MORINAGA

With Plates XXVI–XXVIII

## Introduction

The interspecific hybridization of *Brassica cernua*, HEMSL., or
*Brassica juncea*, COSS., and other species of the genus has been
tried by comparatively few workers. According to SINSKAIA (4)
who recognizes *B. cernua* simply as a synonym of *B. juncea*, *Brassica
juncea* CZERN. does cross neither with *B. nigra* KOCH., *Sinapis
arvensis* L., nor with *Sinapis alba* L., and fairly difficultly with *B.
chinensis* L., *B. pekinensis* RUPR., and *B. campestris* L., while the
crossability of *B. juncea* CZERN., and *B. napus* L. is so high as to
produce in average 6.4 seeds per silique. She raised $F_2$ of *B. juncea*
$\times B.$ *chinensis*, *B. juncea* $\times B.$ *campestris*, *B. juncea* $\times B.$ *pekinensis*,
and also of *B. juncea* $\times B.$ *napus* by either self- or open-pollination.
So far as I am aware, however, none of the workers has reported
the cytological studies on these interspecific hybrids.

The interspecific hybrids of *B. cernua*, or *B. juncea* and other
species of the genus, made in my laboratory with success since 1925
were :—

| | |
|---|---|
| in 1925 | *B. Napella* CHAIX. (Undai) $\times B.$ *juncea* HEMSL. (Katsuona) |
| in 1926 | *B. juncea* HEMSL. (Katsuona) $\times B.$ *pekinensis* RUPR. (Hotorenkekkiu-hakusai) |
| | *B. Napella* CHAIX. (Undai) $\times B.$ *cernua* COSS. (Karashina) |
| | *B. cernua* COSS. (Karashina) $\times B.$ *Rapa* L. (a fodder variety) |
| in 1927 | *B. Rapa* L. (a fodder variety) $\times B.$ *juncea* HEMSL. (Katsuona) |
| | *B. cernua* COSS. (Karashina) $\times B.$ *chinensis* L. (Komatsuna) |

in 1927    *B. cernua* Coss. (Karashina) × *B. chinensis* L. var. *para-*
                                              *chinensis* (Hakkei-taisai)
        ,,                    ,,         × *B. Rapa* L. (Tokinashi-kabu)
        ,,                    ,,         × *B. japonica* SIEB. (Mizuna)
        ,,                    ,,         × *B. Napella* CHAIX. (Undai)
        ,,                    ,,         × *B. Rapa* L. (a fodder variety).

Some of these crosses were repeated also in 1928. The *cernua* or *juncea* characters predominate in the $F_1$ hybrids, especially when those species are crossed with species having ten haploid chromosomes. The $F_1$ hybrids did not produce any viable seeds by self-pollination, but few normal seeds were produced in uncontrolled condition by certain kinds of hybrids. The full description of these $F_1$ and $F_2$ will be made in another opportunity, together with that of various interspecific hybrids of *Brassica* which are not mentioned in the present paper. Here I briefly report only the cytological studies on $F_1$ hybrids of *B. cernua* Coss. (Karashina) × *B. chinensis* L. (Komatsuna), *B. cernua* Coss. (Karashina) × *B. chinensis* L. var. *parachinensis* (Hakkei-taisai), *B. cernua* Coss. (Karashina) × *B. japonica* SIEB. (Mizuna), *B. cernua* Coss. (Karashina) × *B. Rapa* L. (a fodder variety), *B. cernua* Coss. (Karashina) × *B. Rapa* L. (Tokinashi-kabu).

## Material and Methods

Most of the species used in this work were originally grown in the vegetable garden of the experimental farm of the Kyushu Imperial University. "Komatsuna" belongs to the true type of *B. chinensis*, and "Hakkei-taisai" belongs to var. *parachinensis*. The fodder variety of *Rapa* used in this work had been introduced from Europe to our farm several years before I started the experiment. "Tokinashi-kabu" is a real Japanese turnip, and in several characters differs much from European one. Recently I had opportunity to show my materials to Dr. SINSKAIA, and am thankfull to her for her identification of some of my materials. All materials for the present studies were taken from $F_1$ plants raised in 1927–1928.

To study the somatic division the root-tips were fixed in the field with NAWASCHIN's solution. Observing the outline of the reduction divisions by the aceto-carmine-method, I also fixed many anthers with BOUIN's or BENDA's fixatives. The following studies were made exclusively on those fixed materials. Section 10–15 $\mu$

thick were made according to the paraffin method, and stained with iron-alum-haematoxylin.

# The Results of Observation

## *The Chromosomes of the Parental Species*

In the first and the second division metaphase of pollen-mother-cells, *B. cernua* has shown invariably 18 chromosomes. Though all of them assume round shape in the metaphasic plate in both divisions size differences are noticed fairly clearly among them (Fig. 2). I observed 29 metaphasic plates in the second division, of which three contained 6, sixteen 7, and ten 8 small chromosomes. Some size differences are also noticeable among the large chromosomes themselves.

*B. chinensis*, "Komatsuna," has 10 haploid chromosomes, of which some are considerably larger than the others. As I have described in the previous paper (2), the haploid number of chromosomes in each of *B. chinensis* var. *parachinensis* (Hakkei-taisai), *B. Rapa*, and *B. japonica* (Mizuna) is also ten. In short, the results of my observations on the parental species perfectly agree with those reported by SHIMOTOMAI in 1925 (3).

## *The Observations on the $F_1$ Hybrids B. cernua × B. chinensis, and B. cernua × B. chinensis var. parachinensis*

The cytological features of these hybrids are entirely identical to each other. Owing to the poor fixation and minuteness of the somatic chromosomes I could not count them very exactly, but always about twenty-eight were observable in the root-tip cells. The somatic chromosomes varied much in size and some showed a clear constriction about their middle, while some others revealed it at a subterminal position. Special attention was paid to the pollen mother-cell divisions. In the late prophase of the first meiotic division (early diakinesis) I clearly noticed 18 chromosomes lying scattered throughout the nucleus. In very well fixed slides the univalents make sharp contrast to the bivalents at this stage (Fig. 3 and 4). These chromosomes continue to shorten and thicken, and soon attain very compact round forms (true diakinesis), and the distinction of univalents from bivalents become less noticeable

(Fig. 5). When the nuclear membrane disappears the chromosomes show a tendency of aggregation in the center of the nucleus as in parental species (Fig. 6). Soon they are scattered again (Fig. 7, 21), and the bivalents come and take position in the equatorial plane (Fig. 8, 22). I counted the chromosomes on more than 40 mother-cells in such metaphasic condition, and it was found that all of them contained 18 chromosomes, among which 10 bivalents were easily distinguishable from 8 univalents. The bivalents, round in shape, take regular position in the equatorial plane. Bar-shaped univalents are found scattered on the heterotypic spindle though their tendency to arrange themselves on the equatorial plane is more or less recognizable. Few univalents, whose number is variable to some extent in different flowers, may lie in the equator, but always outside the group of bivalents. Some bivalents are, with no doubt, larger than the rest and in "Komatsuna"-hybrid I noticed one bivalent which is especially large (Fig. 8). After the formation of a regular metaphasic plate of bivalents man will never observe regular arrangement of univalents in the equator. Thus there is no chance at all for all eighteen chromosomes to make a single plate or for eight univalents to make the second plate of their own. Now the bivalents begin to disjoin into their respective constituent halves. This stage was observed especially well in *parachinensis* hybrid. As shown in Fig. 23, not only the size but also the shape of disjoining chromosomes seems to be a marked characteristics. Fig. 25 is a slightly later stage showing 2 groups of ten disjoined chromosomes and eight scattered univalents. In good preparation made by using BENDA's fixative, I often observed the disjoined halves of the bivalents which clearly show the splitting (Fig. 24). In Fig. 23 there is only one univalent in the equator while in Fig. 25 there is none. The univalents situated outside the equator pass undivided to the nearer pole, and they ultimately make company with the disjoined halves of bivalents. The univalents which lie near the equator keep the position as lagging chromosomes until the disjoined chromosomes reach near the poles. The splitting of the lagging univalent becomes pronounced now, and split halves are mostly separated to some extent. Fig. 9 shows a group of pollen mother-cells in such a stage. The lagging univalents in late anaphase generally keep position on the surface of the spindle. Later the halves of some split univalents are undoubtedly distributed to the opposite poles, but the halves of

most univalents travel together to the nearer one.   Though, in general, the univalents are included in the reforming nuclei, a few univalents or only halves of them may be left behind in the cytoplasm.   The reconstruction of the daughter nuclei does not proceed far, since the first division is followed closely by the second.   In the homotypic division when the chromosomes first appear on the spindle they take fairly aberrant position, but soon they arrange themselves regularly in the equator, with only one or two exceptional ones found slightly out of the plate or rather near to the pole.   The number of chromosomes which appear on the homotypic spindles, however, varied greatly from spindle to spindle.   It is very important to know the frequency distribution of the number of chromosomes on those spindles to get a thorough understanding of the previous division.   From 60 and 139 metaphasic countings on *chinensis*, and *parachinensis* hybrids respectively, the following table showing the frequency distribution of chromosome numbers was compiled.

### TABLE I.   Frequency distribution of chromosome numbers in homotypic metaphase

| Numbers of chromosomes | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | Total | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *B. cernua × B. chinensis* — 1. Chrs. in equatorial plane only.... | 1 | 1 | 8 | 10 | 20 | 12 | 5 | 2 | 1 | 60 | 13.98±0.19 |
| 2. All chrs. on the spindle......... | 0 | 0 | 6 | 6 | 19 | 11 | 12 | 3 | 3 | 60 | 14.63±0.24 |
| 3. Theoretical..... | 0.2 | 1.9 | 6.6 | 13.1 | 16.4 | 13.1 | 6.6 | 1.9 | 0.2 | — | — |
| *B. cernua × B. chinensis var. parachinensis* — 1. Chrs. in equatorial plane only.... | 2 | 6 | 11 | 23 | 41 | 33 | 20 | 3 | 0 | 139 | 14.08±0.12 |
| 2. All chrs. on the spindle......... | 0 | 1 | 4 | 13 | 27 | 26 | 36 | 29 | 3 | 139 | 15.24±0.13 |
| 3. Theoretical..... | 0.5 | 4.3 | 15.2 | 30.4 | 38.0 | 30.4 | 15.2 | 4.3 | 0.5 | — | — |

Besides the chromosomes which lie in the spindle we often find in the cytoplasm one or two chromosomes which were excluded out of the nucleus in the previous division.   Fig. 10 and Fig 26 show two cells in homotypic metaphase.   In Fig. 10 there are fourteen chromosomes in one plate and thirteen chromosomes in the other, also there is for each spindle one chromosome which is situated outside the equatorial plate.   In Fig. 26 there are twelve and fifteen chromosomes in the respective plates and beside these we see one

and two chromosomes in the one and the other plate respectively, which are found deviating from the normal position. In the homotypic anaphase the chromosomes in the equator first divide in normal way, but those situated outside the plate are left undivided until later. In Fig. 11, in one spindle we observe two daughter groups of fifteen chromosomes and one intact chromosome situated near one pole, while in the other there are two groups of twelve chromosomes and one unsplit chromosome between the groups. In a slightly later stage the lagging chromosomes are more easily observable. Counting on 60 homotypic spindles I calculated the average number of lagging chromosomes as 1.1. Lagging chromosomes show clear splitting, and the halves are often separated to some extent (Fig. 12). Fig. 13 shows four microspore nuclei and some split lagging chromosomes left in the cytoplasm.

## Some Irregularities Observed

(1) Degeneration of pollen mother cells. Sometimes the cytokinesis of the last archesporial cell division is impeded to some degree. In extreme cases, as shown in Fig. 14, the whole anther locule is occupied with a large protoplasmic mass containing many nuclei. Some of the latter are clearly degenerating, but some survive and show meiotic process to some extent (Fig. 15). In these conditions the fusion of nuclei will occur easily to make giant ones as shown in Fig. 16 and Fig. 17. Figs. 18–20 show some abnormal forms found in less degenerated locules.

(2) Supernumerary spindles. More than two homotypic spindles seem to be formed very rarely in these hybrids (Fig. 27).

(3) Union of two homotypic plates. The two homotypic spindles may be formed perpendicularly, obliquely or parallel to each other. When parallel spindles are formed very closely, two homotypic plates are intersected. Such plates are rarely observed in these hybrids, and dyads instead of tetrads will be produced in this case.

(4) Union of two daughter chromosome groups in homotypic division. When two homotypic spindles in one plane are not parallel, two daughter groups out of four may join to make a single nucleus. Such a case was observed in the *chinensis* hybrid. Triads instead of tetrads will be formed in this case.

(5) Deranged homotypic divisions. Fig. 28 shows a

deranged homotypic division.  On the left spindle the daughter groups are fairly well separated, while chromosomes on the right spindle show very irregular appearance and not only the separation, but also the division seems to have been prevented.  Dyads or triads may also be formed by this process.  In Fig. 29 I depicted several pollen mother-cells in homotypic telophase observed in the same slide as Fig. 28.

### *B. cernua* × *B. japonica*, *B. cernua* × *B. Rapa* (*a fodder variety*) and *B. cernua* × *B. Rapa* (*Tokinashi-kabu*).

The cytological features of these $F_1$ hybrids are essentially the same as the forementioned *chinensis* hybrids.  I present here only some figures and tables to show their similarity.  Figs. 31, 34 and 35 are heterotypic metaphase depicted respectively from *B. cernua* × *B. japonica*, *B. cernua* × *B. Rapa* (a fodder variety), and *B. cernua* × *B. Rapa* (Tokinashi-kabu).  All of these figures show eighteen chromosomes, and ten bivalents are easily distinguishable among them.  Twenty-eight somatic chromosomes in the root-tip cell of *B. cernua* × *B. Rapa* (fodder variety) are shown in Fig. 33.  Fig. 36, which is drawn from *B. cernua* × *B. Rapa* (fodder variety), show early anaphase of the heterotypic division and 8 univalents and 20 disjoined halves of bivalents are distinctly observable.  Fig. 32 and 37 show two pollen mother-cells in homotypic metaphase from *B. cernua* × *B. japonica* and *B. cernua* × *B. Rapa* (fodder variety). The frequency table of the numbers of chromosomes in the second division metaphase is as follows :

TABLE II.  Frequency distribution of chromosome numbers in homotypic metaphase

| | | Number of chromosomes | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | Total | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency | *B. cernua* × *B. japonica* | 1. Chrs. in equatorial plane only.... | 1 | 5 | 10 | 19 | 26 | 29 | 18 | 6 | 1 | 2 | 0 | 117 | 14.33±0.15 |
| | | 2. All chrs. on the spindle.......... | 0 | 1 | 5 | 7 | 22 | 37 | 26 | 15 | 1 | 2 | 1 | 117 | 15.15±0.14 |
| | | 3. Theoretical ..... | 0.5 | 3.7 | 12.8 | 25.6 | 32.0 | 25.6 | 12.8 | 3.7 | 0.5 | 0 | 0 | — | — |
| | *B. cernua* × *B. Rapa* (fodder variety) | 1. Chrs. in equatorial plane only ... | 1 | 4 | 7 | 15 | 20 | 15 | 13 | 0 | 0 | 0 | 0 | 75 | 14.37±0.16 |
| | | 2. All chrs. on the spindle ......... | 0 | 1 | 4 | 12 | 11 | 18 | 13 | 13 | 3 | 0 | 0 | 75 | 14.96±0.19 |
| | | 3. Theoretical ..... | 0.3 | 2.3 | 8.2 | 16.4 | 20.5 | 16.4 | 8.2 | 2.3 | 0.3 | 0 | 0 | — | — |

In *japonica* hybrid I found in average 2.2 chromosomes lagging in the homotypic anaphase.

## General Remarks

The karyological features in $F_1$ hybrids of *B. cernua* (n=18) and any one of the species *B. chinensis* (n=10), *B. japonica* (n=10) and *B. Rapa* (n=10) are entirely identical. The chromosome number in somatic cells of $F_1$ hybrids is no doubt twenty-eight which corresponds to the sum of the numbers of chromosomes contained in both gametes. The somatic chromosomes of the hybrid varied in size and shape, and are characterised by the position of constrictions. In the late heterotypic prophase eighteen chromosomes are counted, among them about eight chromosomes are distinguished from the other by their single nature, but at the end of diakinesis, owing to their shortening and thickening, this distinction becomes somewhat obscure. When the nuclear membrane disappears before entering metaphase, the chromosomes show a tendency of aggregation; this phenomenon, often called third contraction, however, might be intensified more than it is really the case, by fixation. The chromosomes are soon scattered again and the round-shaped bivalents, constantly ten in number, take their position on the equatorial plane. The size differences are clearly noticed among the bivalents. The univalents, eight in number, show slight or, in some cases, no tendency of orientation to the equator. They are usually scattered on the surface of the spindle, but occasionally take position in the equatorial region, outside the group of bivalents. The univalents, even later, never move to the equator as reported for *Triticum* type hybrids (1). In the anaphase ten bivalents are disjoined and the resulting halves are distributed regularly to the poles, some of which show later clear splitting. In well made slides the early anaphase provides excellent figures to study the size and shape of the bivalents. The univalents situated far out of the equatorial region move undivided to the poles, while those which lie near the region keep the position and come to show clear splittings. Sometimes the split halves of the univalents are distributed to the opposite poles, but usually, though they often separate to some extent, travel together to the same pole. Homotypic chromosomes first take irregular position on the spindle, but soon, with only one or two exceptional ones, they are arranged in the equatorial plane. The behaviors of

univalents, especially their modes of division in the heterotypic mitosis, have a direct effect on the numbers of chromosomes appearing in the homotypic metaphase. So the exact countings of the chromosomes on the homotypic spindle are necessary for thorough understanding of the behaviors of univalents in the preceding division. As shown in Table I, in the homotypic metaphases of *cernua-chinensis* or *cernua-parachinensis* hybrid fourteen chromosomes appear most frequently in the equator. When we take into account only the chromosomes situated in the plane, we notice well the agreement of the observed numbers with the frequency calculated on the assumption of chance distribution of all eight intact univalents to heterotypic poles, and no exclusion of any of them from the reforming nuclei. The average numbers calculated are $13.98 \pm 0.19$ and $14.07 \pm 0.12$ respectively for *cernua-chinensis* and *cernua-parachinensis* hybrid, while if we take account the whole chromosomes on the homotypic spindle, the average numbers increase respectively to $14.63 \pm 0.24$ and $15.24 \pm 0.13$. Similar results in *cernua-japonica* and *cernua-Rapa* hybrid will be noticed in Table II. As the $F_1$ hybrids treated in the present paper show essentially identical behaviors of chromosomes, the results of four kinds of hybrids are collected, and the following table for the frequency distribution is obtained.

TABLE III. Frequency distribution of chromosome
numbers in homotypic metaphase

| Number of chromosomes | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | Total | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Chrs. in equatorial plane only .... | 5 | 16 | 36 | 67 | 107 | 89 | 56 | 11 | 2 | 2 | 0 | 391 | $14.12 \pm 0.08$ |
| 2. All chrs. on the spindle.......... | 0 | 3 | 19 | 38 | 79 | 92 | 87 | 60 | 10 | 2 | 1 | 391 | $15.07 \pm 0.08$ |
| 3. Theoretical ..... | 1.5 | 12.2 | 42.8 | 85.5 | 106.9 | 85.5 | 42.8 | 12.2 | 1.5 | 0 | 0 | — | — |

(left margin label: Frequency)

In fact, however, the respective halves of some univalents divided in the heterotypic division will be distributed to the opposite poles, and few chromosomes are found in the cytoplasm at the end of the division. In *cernua-chinensis* hybrid the calculation shows that we have in average slightly more than one such chromosome for each interkinesis or homotypic metaphase. From these numerical observations and calculations I might say that in average the number of chromosomes contained in the pollen mother-cell at the end of the heterotypic division is thirty-one, of which one is excluded out

of the nuclei. Thus it seems to me probable that three univalents, in average, are divided completely in the heterotypic division, thus increasing the corresponding number of chromosomes, and that one out of those six divided halves is left in the cytoplasm, and three out of them are included in one daughter nucleus, while the rest are taken into the other one. Also I might say that the divided halves of univalent chromosomes take, with nearly equal chance, the position exactly in or out of the equatorial plane in the homotypic metaphase. The lagging chromosomes in the heterotypic anaphase are no doubt the halves of univalents divided in the preceding mitosis. The splitting observed in the lagging chromosome is, therefore, the second splitting of the univalent which occurred in a single meiosis. So far as my studies on *Brassica* hybrids are concerned, all univalents seem to have a tendency to be split twice in the meiosis, but many of them fail to divide in the heterotypic mitosis chiefly on account of their improper position on the spindle. And even though situated in the equator, halves of univalents divided in the heterotypic mitosis generally do not complete the division in the homotypic mitosis as they have not been enough prepared for division when the second mitosis is started.

In short, the reduction divisions in the present hybrids clearly belong to *Pilosella* type (5) and except the presence of eight chromosomes instead of nine in the heterotypic metaphase, the chromosomal behaviors are quite similar to those observed in the hybrids of *B. Napella* (n=19) and other species of *Brassica* with ten chromosomes (2).


P. S.—When I have just finished this manuscript, the paper " Bastardierungsversuche bei *Brassica* und *Raphanus* " by Y. TERASAWA and N. SHIMOTOMAI was received. Some discussion on this paper will be made in near future.

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KYUSHU IMPERIAL UNIVERSITY

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# Explanation of Plates XXVI-XXVIII

Excepting Figs. 9, 14-20 and 29, all figures in Plates XXVI-XXVIII are drawn at a level lower than the table with the aid of ABBE's large camera under a ZEISS apochromatic objective 1.5 mm. and compensation ocular 18, magnification 5,000. Fig. 9 and 14-20 were drawn on the table under same objective 1.5 mm. and compensation ocular 8. Fig. 29 was drawn on the table with the same objective and compensation ocular 18. All the original drawings have been reduced to one half of the original size.

Fig. 1. *B. chinensis*, L. (Komatsuna). Heterotypic metaphase (n=10).

Fig. 2. *B. cernua* Coss. Homotypic metaphase (n=18).

Figs. 3, 4, 5. $F_1$ of *B. cernua* × *B. chinensis*. Late prophases in heterotypic division showing gradual shortening and thickening of 18 chromosomes. Univalents are fairly well distinguished from bivalents.

Fig. 6. $F_1$ of *B. cernua* × *B. chinensis*. Third contraction.

Fig. 7. $F_1$ of *B. cernua* × *B. chinensis*. Early heterotypic metaphase before complete formation of equatorial plate.

Fig. 8. $F_1$ of *B. cernua* × *B. chinensis*. Heterotypic metaphase showing 10 bivalents and 8 univalents.

Fig. 9. $F_1$ of *B. cernua* × *B. chinensis*. A group of P-M-C-s in heterotypic anaphase.

Fig. 10. $F_1$ of *B. cernua* × *B. chinensis*. Homotypic metaphase showing 13+1 and 14+1 chromosomes in each plate.

Fig. 11.  F₁ of *B. cernua* × *B. chinensis*.  Homotypic anaphase showing two groups of 12 daughter chromosomes and one lagging chromosome in one spindle and two groups of 15 daughter chromosomes and one chromosome near one pole in the other.

Fig. 12.  F₁ of *B. cernua* × *B. chinensis*.  Homotypic anaphase showing splittings of lagging chromosomes.

Fig. 13.  F₁ of *B. cernua* × *B. chinensis*.  Showing 4 microspore nuclei and some lagging chromosomes left in cytoplasm.

Fig. 14.  F₁ of *B. cernua* × *B. chinensis*.  A large cytoplasmic mass containing many nuclei, some are degenerating.

Fig. 15.  F₁ of *B. cernua* × *B. chinensis*.  A large cytoplasmic mass containing several nuclei showing meiotic processes.

Figs. 16–20.  F₁ of *B. cernua* × *B. chinensis*.  Abnormal large cytoplasmic mass containing queer mass of chromosomes, division figures and nuclei.

Fig. 21.  F₁ of *B. cernua* × *B. chinensis* var. *parachinensis*.  Heterotypic early metaphase showing 18 chromosomes.

Fig. 22.  F₁ of *B. cernua* × *B. chinensis* var. *parachinensis*.  Heterotypic metaphase showing 10 bivalents and 8 univalents.

Fig. 23.  F₁ of *B. cernua* × *B. chinensis* var. *parachinensis*.  Heterotypic early anaphase showing 10 disjoining bivalents and 8 scattered univalents.

Fig. 24.  F₁ of *B. cernua* × *B. chinensis* var. *parachinensis*.  Heterotypic anaphase showing splittings in some disjoined halves.

Fig. 25.  F₁ of *B. cernua* × *B. chinensis* var. *parachinensis*.  Heterotypic anaphase showing 2 groups of 10 disjoined chromosomes and 8 scattered univalents.

Fig. 26.  F₁ of *B. cernua* × *B. chinensis* var. *parachinensis*.  Homotypic metaphase showing 12+1 and 15+2 chromosomes in each plate.

Fig. 27.  F₁ of *B. cernua* × *B. chinensis* var. *parachinensis*.  A P-M-C with 3 homotypic spindles.

Fig. 28.  F₁ of *B. cernua* × *B. chinensis* var. *parachinensis*.  Abnormal homotypic anaphase.

Fig. 29.  F₁ of *B. cernua* × *B. chinensis* var. *parachinensis*.  Several abnormal P-M-C-s in homotypic telophase.

Fig. 30.  F₁ of *B. cernua* × *B. chinensis* var. *parachinensis*.  Dyad formation.

Fig. 31.  F₁ of *B. cernua* × *B. japonica*.  Heterotypic metaphase showing 10 bivalents and 8 univalents.

Fig. 32.  F₁ of *B. cernua* × *B. japonica*.  Homotypic metaphase showing 14 and 16+1 chromosomes in each plate.

Fig. 33.  F₁ of *B. cernua* × *B. Rapa* (fodder variety).  28 somatic chromosomes in root-tip cell.

Fig. 34.  F₁ of *B. cernua* × *B. Rapa* (fodder variety).  Heterotypic metaphase showing 10 bivalents and 8 univalents.

Fig. 35.  F$_1$ of *B. cernua* × *B. Rapa* (Tokinashi-kabu).   Heterotypic metaphase
  showing 10 bivalents and 8 univalents.

Fig. 36.  F$_1$ of *B. cernua* × *B. Rapa* (fodder variety).   Heterotypic anaphase
  showing 2 groups of 10 disjoined halves and 8 scattered univalents.

Fig. 37.  F$_1$ of *B. cernua* × *B. Rapa* (fodder variety).   Homotypic metaphase
  showing 12 and 16 chromosomes in each plate.
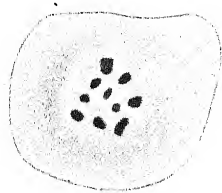
PLATE XXVI

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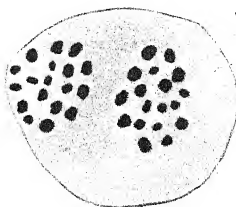
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PLATE XXVII



14

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PLATE XXVIII



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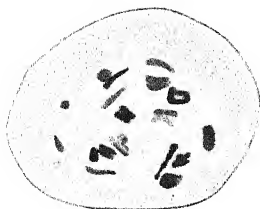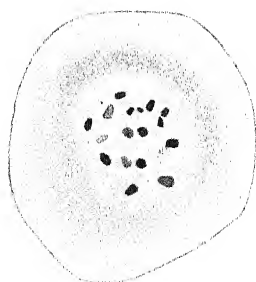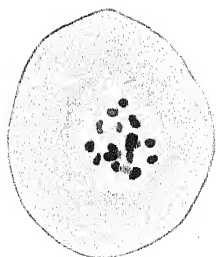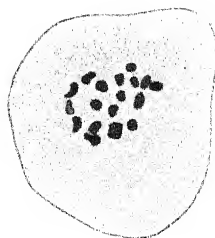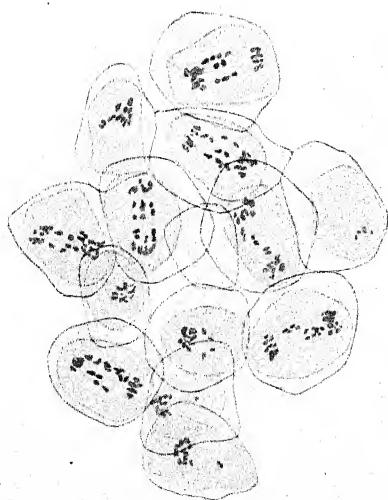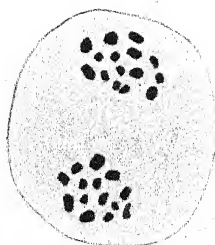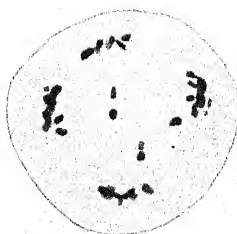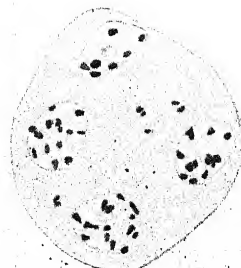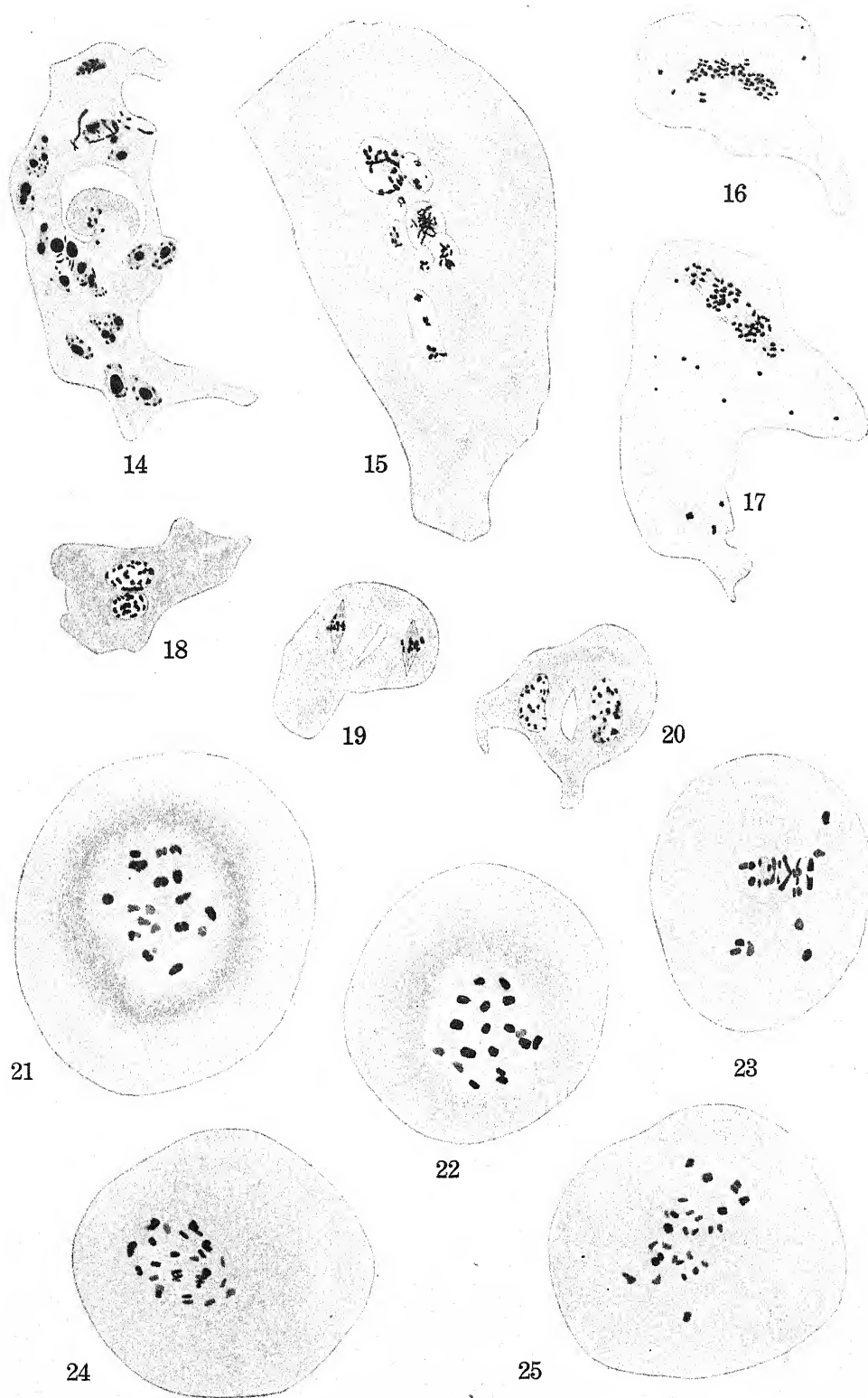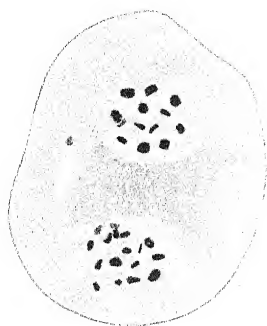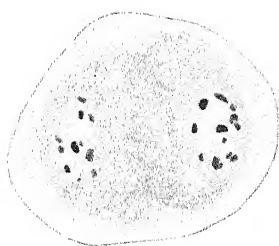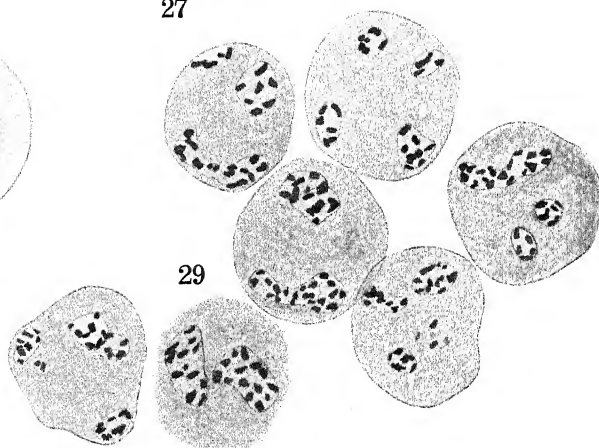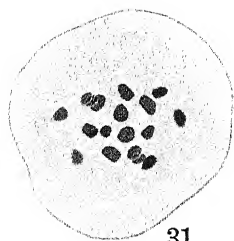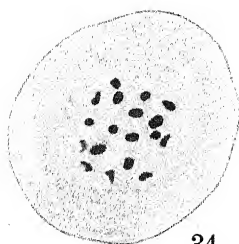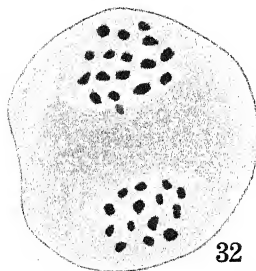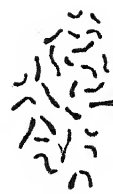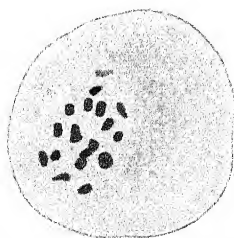
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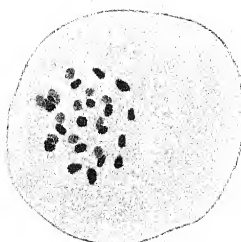
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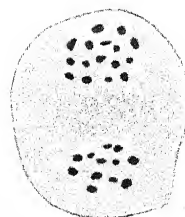
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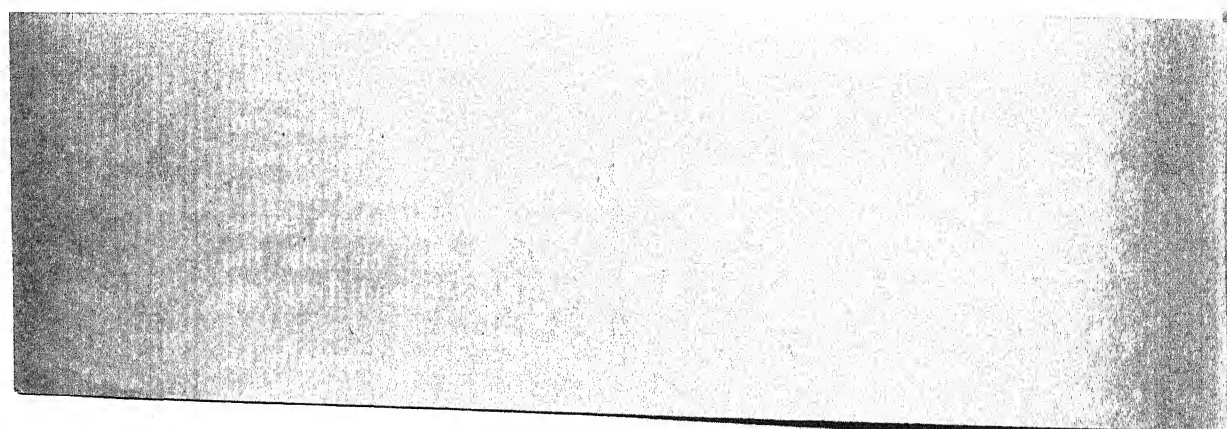
# On Some New Japanese Fungi

By Seiichi KAWAMURA

## I.  A New Fungus Parasitic on Bamboo

Upon many species of bamboo in Japan and elsewhere there occasionally appear the growths of parasitic fungi.  When these are removed and the culm dried and polished, discoloured areas appear which make the bamboo thus affected suitable for various ornamental uses, such as for making brush handles, pipes, fan ribs, and so on. Some time ago the writer published a description[1] of the fungus producing the so-called " Tiger-figured " bamboo (" Torafudake "). He has now to report upon another species of fungus which causes an appearance which, for purposes of identification, he calls the " Panther-figured " bamboo (cf. Pl. XXIX, fig. 1-2, and Text-figs. 1-4).

A culm of bamboo bearing this fungus was found originally by Mr. A. YAMAGUCHI at Heito, Formosa, and sent by him to Professor ASAHINA, who believed the fungus to be the same as that previously published (*v. sup.*) and forwarded it to the writer.  On examination in detail, however, it proved to be an entirely new species.

It grows upon the bamboo known as " Sekikaguchiku " (*Bambusa Shimadai*), and is smoky-black in colour, with a thick aerial mycelium like rubbed old leather.  This aerial mycelium we can easily remove from the surface of the culm, whereupon the figure appears.  The mycelial layer is about 1 mm. thick, and is composed of parallel or interwoven blackish-brown mycelia $4\,\mu$ in diameter. Here and there in the layer pear-shaped blackish perithecia stand imbedded perpendicularly to the surface of the culm, and therefore projecting horizontally in the normal position of the growing plant (Text-fig. 5).  The excised perithecium is found to have a hard, brittle wall ; its main part is globose, with a prolonged beak, the whole length being 0.8 mm and the diameter 0.5 mm (Text-fig. 6).

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(1)   Jour. Coll. Sci., Imp. Univ. Tokyo, Japan **23**, 2 (1907).

On its surface grow many blackish-brown mycelia, and attached to
its inner wall are many asci with protecting paraphyses (Text-fig. 7).
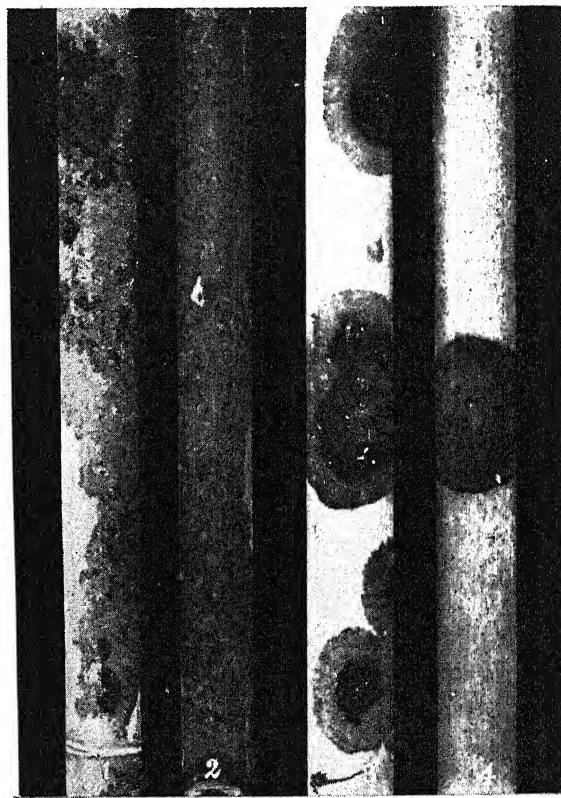


Fig. 1–4

Fig. 1.  The "panther-figured" bamboo covered with aerial mycelium
of *Miyoshiella macrospora*, KAWAMURA.  2/3.

Fig. 2.  Ditto.  The aerial mycelium was removed, whereupon the figure
of the surface of the culm appears.  2/3.

Fig. 3.  The "tiger-figured" bamboo with aerial mycelium of *Miyoshi-
ella fusiformis*.  2/3.

Fig. 4.  Ditto.  Without aerial mycelium.  Showing the single figure of
normal form.  2/3.

The form of the ascus is cylindrical, more or less curved, with
a thick wall in the apical portion and a mouth-pore much resem-
bling that of the nematoda.  The size of the ascus is 300–450 × 25 $\mu$.
Each contains eight spores which, when immature, are unicellular
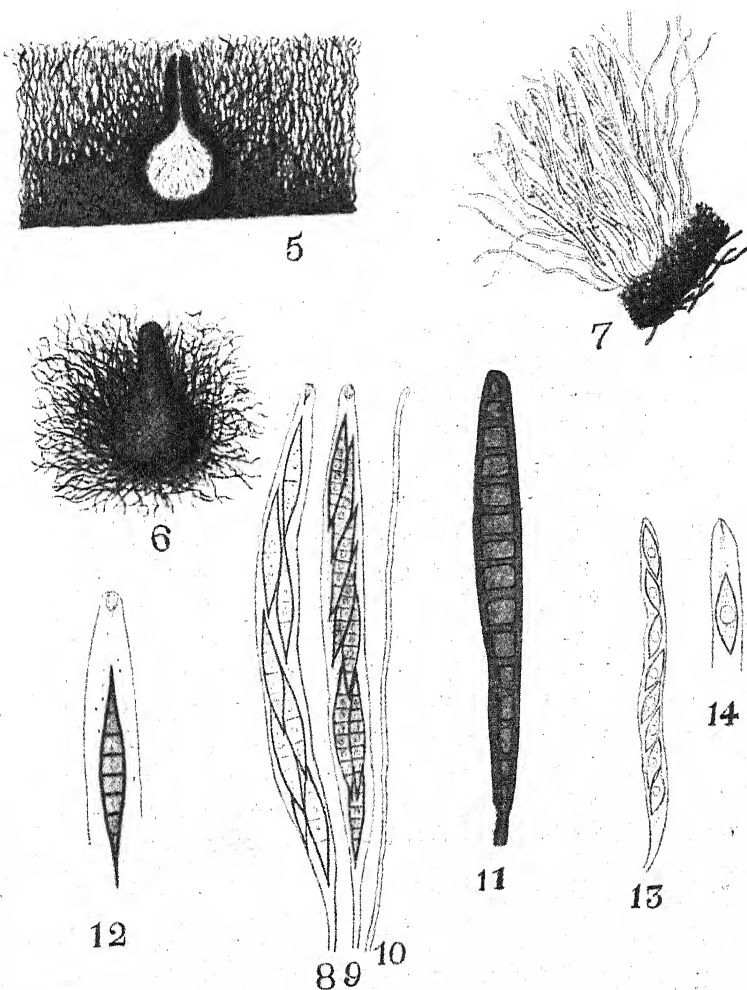
Fig. 5–12, *Miyoshiella macrospora*, KAWAMURA

5) Sectional view of the aerial mycelial layer of the fungus, showing the longitudinal section of a perithecium imbedded in the layer (25/1).    6) Perithecium (25/1).    7) A piece of perithecium (80/1).    8) Ascus with young spores (200/1). 9) Ascus with mature spores (200/1).    10) Paraphysis (200/1).    11) Conidium (300/1).    12) Apical part of an ascus and a spore (350/1).

Fig. 13–14 *Miyoshiella fusispora*, KAWAMURA

13) Ascus (200/1).    14) Apical part of an ascus and a spore (350/1).

and transparent, but in the mature state are of light blackish-brown colour and divided by several (usually seven) septae. At all times the spores contain many oil-drops; their size is $70-120 \times 14-15 \mu$. (Text-figs. 8, 9, 10).

The paraphysis is transparent, of slender cylindrical form with many septae.

The conidia are formed somewhat in the shape of a bean pod, and are blackish-brown, with thick walls and many septae; size: $150-300 \times 20-25 \mu$ (Text-fig. 11). At the point of attachment is a foot of diameter nearly equal to that of the sustaining mycelium.

Comparing this fungus with that of the "tiger-figured" bamboo, we find that the general feature of the mycelial layer is almost alike, but the comparison of the perithecium, ascus, ascospore, and conidium reveals sharp differences. In the "tiger-figured" bamboo all are smaller (perithecium $5-6 \times 3-4$ mm, ascus $190-220 \times 12 \mu$, ascospore $28-38 \times 6-8 \mu$, conidium $50-120 \times 5-15 \mu$). The ascospore is short fusiform, always transparent and unicellular until just before germinating, when septa appear. The difference in size is here particularly noticeable, the ascospore of the new fungus being more than twice as large as that of the "tiger-figured" bamboo. The spores of the new fungus in their position in the ascus are deeply overlapped, causing great thickness of the ascus, whereas in the fungus of the "tiger-figured" bamboo they are arranged in a single column, allowing the ascus to be proportionally much thinner. These points of distinction make microscopical differentiation of the two species an easy matter (Text-figs. 13, 14).

Even without the microscope we can distinguish them by the general form of the figure in the dried and polished bamboo. In the "tiger-figured" bamboo the spots are large and isolated; in the "panther-figured" the pattern produced is that of a large dark area with a confused grouping of small darker spots. Another notable difference is that of the host, for the "panther-figure" as noted above, appears on *Bambusa Shimadai*, while the "tiger-figure," as far as is known, is confined to the bamboo known as "Narihiradake" (*Semiarundinaria fastuosa*). It must not be supposed, however, that the new fungus is simply that of the "tiger-figured" bamboo somewhat modified by transference to a new host, for its histology at once proves the impossibility of such a conclusion.

There is no question that this fungus belongs to the class Sphaeriales of the section Ascomycetes. The determination of the family

is less automatic, for the new fungus partakes of the characteristics of both the Sphaeriaceae and the Cerastomataceae, the fruit body having the thick brittle wall of the former family, with the elongated form of the latter. But the perithecium in the Cerastomataceae has always a thin, flexible wall, which is especially noticeable in the elongated distal portion, while the thick, brittle-walled perithecia of the Sphaeriaceae do sometimes develop a pear-shaped rather than a spheroidal form, as in the case of *Trichosphaeria*. Therefore the writer feels justified in assigning the new fungus, for the present, to the Sphaeriaceae.

In this family, some genera have the fruit-body growing under the surface of the host plant; in others it is imbedded in a stroma of woody, matted mycelia, and in others it grows nearly naked upon the surface. But in the present case it grows under the protection of a soft mass of interwoven mycelia, necessary because of the smooth, hard, impervious surface of its host. The only other fungus having the perithecium protected in this fashion is that of the "tiger-figured" bamboo, which the writer more than twenty years ago assigned (*op. cit.*) to the then new genus *Miyoshia*. Therefore the present fungus belongs in the same genus, but its differential characteristics above noted place it in a separate species, for which the writer suggests the name *macrospora*. At the same time he takes a convenient opportunity to offer a slight change in the name of the genus, for the purpose of avoiding any possible confusion which might arise from the temporary use of the generic name *Miyoshia* by Mr. T. MAKINO in classifying the flowering plant now known as *Petrosavia Miyoshia-Sakuraii*, (cf. Bot. Mag. Tokyo 18, 208 (1903)). In place of the name *Miyoshia* the writer therefore suggests the generic name *Miyoshiella*, which will thus include, at present, the two species *Miyoshiella fusispora* and *Miyoshiella macrospora*.

### *Miyoshiella macrospora*, KAWAMURA, sp. nov.

Aerial mycelial layer smoky-black, about 1 mm thick; mycelium blackish-brown, 3–4 $\mu$ in diameter; perithecium pear-shaped, hard, brittle, wall about 100 mm thick, main part globose, with prolonged beak, 8×5 mm; ascus cylindrical, more or less curved, 300–450×25 $\mu$, ascospore fusiform, light blackish-brown, with several (usually seven) septae, 70–120×14–15 $\mu$; paraphysis slender cylindrical, with many

septae; conidium bean-pod-shaped, blackish-brown, with many septae, 150–300 × 20–25 $\mu$.

Grows upon the bamboo, *Bambusa Shimadai*, HAY.

Loc. Heito, Formosa, Japan.

The figured bamboo culm, infected by this fungus, is called " Panther-figured " bamboo.

### *Miyoshiella fusispora*, KAWAMURA
### (Syn. *Miyoshia fusispora*, KAWAMURA)

Aerial mycelial layer is smoky-black, about 600 $\mu$ thick; mycelium blackish-brown, 3–4 $\mu$ in diameter; perithecium pear-shaped, hard, brittle, main part globose, with prolonged beak 5–6 × 3–4 mm; ascus cylindrical, more or less curved, 190–220 × 12 $\mu$; ascospore fusiform, colourless, unicellular, 28–38 × 6–8 $\mu$; paraphysis slender cylindrical, with many septae, 50–120 × 5–15 $\mu$.

Grows upon the bamboo, *Semiarundinaria fastuosa*. (Syn. *Arundinaria narihira*).

Loc. Prov. Mimasaka and Prov. Hyuga, Japan.

This figured bamboo culm, infected by this fungus, is called " Tiger-figured " bamboo.

The writer begs to express his gratitude to Professors MIYOSHI and MIYABE for invaluable advice and assistance, as well as to Professor ASAHINA for originally bringing the fungus to his attention.

*Summary :*

1. A species of parasitic fungus from Formosa, producing an ornamental pattern upon its host bamboo, is mycologically described.

2. It is distinguished from the somewhat similar fungus hitherto known as *Miyoshia fusispora*.

3. It is classified in section Ascomycetes, class Sphaeriales, family Sphaeriaceae, genus *Miyoshiella* (changed from *Miyoshia*), species *M. macrospora*.

## II. Note on a Rare Bamboo-parasitic Fungus in Japan

In connection with the study of fungi parasitic on bamboo it is interesting that there have recently been discovered in the island of

Kyushu, by Mr. T. ANDO, who has kindly sent an infested culm to the writer, specimens of *Micropeltis bambusicola*. This fungus is that of the so-called "Chinese-figured bamboo" which has not hitherto been recorded in Japan, and is especially characterized by absence of visible pileus and mycelium and by the small size of the infected patches. As hitherto recorded this fungus lives on the bamboo "Nema-garidake" (*Sasa paniculata*). The specimens from Kyushu, however, take a different host, "Narihiradake" (*Semiarundinaria fastuosa*).

## III.  The Japanese Spider-Parasitic Fungus

The late Prof. A. YASUDA described and illustrated in "Shinsen Nippon Shokubutsu Zusetsu" for July, 1899 (p. 50 and Pl. XXV) a certain fungus growing as parasite upon a local earth-spider called "Jigumo" (*Atypus* sp.). He identified it with the European species *Isaria arachnophila*, and his terminology has since been adopted by all botanists. I have used it in my "Illustrations of Japanese Fungi" (Vol. I, Table 4) published by the Bureau of Forestry 1912.

Prof. YASUDA based his description on a single type-specimen collected by Baron H. MATSUDAIRA at Shimonegishi, Shitaya-ku, Tokyo, but the present location of this specimen is uncertain; it may be in the C. G. LLOYD's collection, Cincinnati, Ohio, U. S. A. After his original publication Prof. YASUDA came to the conclusion that he had been mistaken in his identification, and that the fungus in question was really a new species, wherefore he assigned it the name *Isaria atypicola* on account of its host (Bot. Mag. Tokyo, Vol. 26, No. 367, July, 1917).

Recently I had an opportunity to inspect at Kew Garden Herbarium, London, the type-specimen of *Isaria arachnophila*, and observed it to be a nearly microscopic mycological specimen. Prof. YASUDA's species is many times larger, and this confirms his view of the difference between them.

It has long been thought that Prof. YASUDA's description of the spider-parasitic fungus covered the only Japanese species of the kind, but there seems to be here an interesting discrepancy. For there is a common Japanese species of this type which apparently does not identify itself with Prof. YASUDA's specimen. In the first place it takes an entirely different host, for it is *always*, as far as a rather extensive observation shows, found on *Pachylomerus fra-*

*garia*, and *never* on *Atypus*. Again, in Prof. YASUDA's plate, the fungus is shown springing from the head of the fully visible host, while in this common species, in all of many specimens which I have observed, the body of the spider is completely encased in the stroma of the fungus which forms a cocoon-like body of white tissue which must be dissected away to show any portion of the
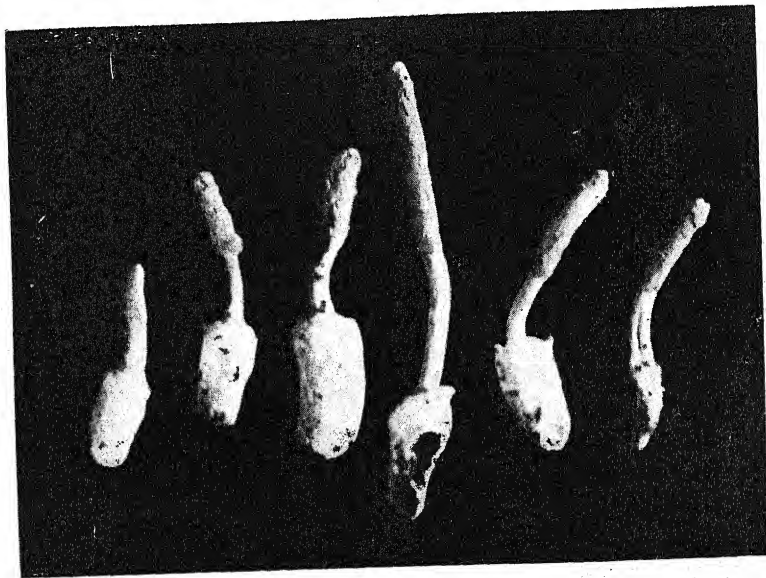


Fig. 15. *Isaria pachylomera*, KAWAMURA (natural size), springing up from a white, thick, cocoon-like stroma which is imbedded in the body of host spider. (The spider nest is removed).

spider. Finally, Prof. YASUDA's species is shown as having a conidium distinctly curved, while the common form has a conidium of linear oblong form ($4-5 \times 2\,\mu$) curved at most but slightly.

It had been my intention to discuss with Prof. YASUDA and Baron MATSUDAIRA this interesting question, endeavouring to ascertain whether, by any chance, there might have been any inaccuracy in the original description, but I was prevented from doing so by the death of both scientists. Under the circumstances, therefore, we must accept Prof. YASUDA's description and illustrations as given, and assume *I. atypicola* to be a species quite distinct from the common Japanese spider-parasitic fungus which has thus remained hitherto unnamed, and for which I suggest the name *Isaria pachy-omera*, giving its description as follows:

## *Isaria pachylomera*, KAWAMURA, sp. nov.

Mycelium thickly covers body of host spider.   Fruit body springs up from a white, thick, cocoon-like stroma 1–3 cm × 6–12 mm. Stem cylindrical, lower third naked whitish 1–3 cm × 3–4 mm.   Upper two-thirds covered with conidia which in mass appear pinkish though transparent under the microscope, 3–5 cm × 3–7 cm. Conidia linear oblong or slightly curved, 4–5 × 2 μ.   Host, *Pachylomerus fragaria*, lives in underground nest somewhat similar to that of common Californian "trap-door spider;" usually found in gardens or spots of bare ground; the fungus therefore is largely hidden, only the upper part of the conidia-bearing stem appearing above the surface.   The fungus appears especially in the month of June.   The first occasion which I collected several specimens of this fungus, was in the Tokyo Botanical Garden, June 27, 1908.   Almost every year since then I have collected the fungus in Tokyo or elsewhere in Japan.   (Pl. XXIX, fig. 3, Text-fig. 15).
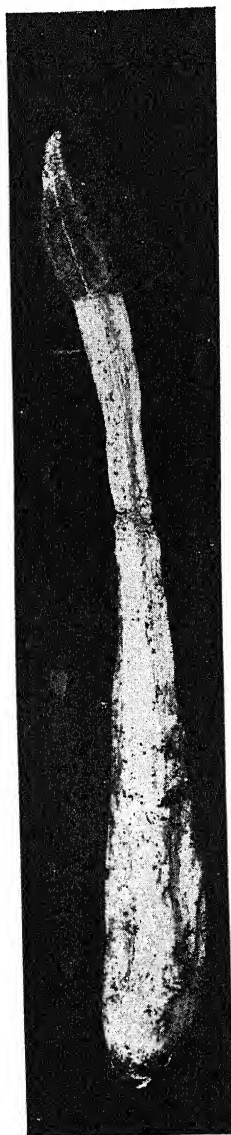


Fig. 16. *Mutinus coracoideus,* KAWAMURA (natural size).

## IV.  A New *Mutinus* Fungus

The following description concerns a new fungus of the genus *Mutinus* recently discovered by the writer in the experimental garden of the Higher Horticultural School at Matsudo (near Tokyo), Japan. (Pl. XXIX, fig. 4; Text-fig. 16).

Entire plant hollow. Stem ridged pentagonal, 14 cm long, tapering from both extremities toward the central region; diameter 1.2 cm maximum, 0.8 cm minimum. At the top a slightly swollen gleba, 2 cm long, surmounted by a cellular apical portion in shape like the beak of a crow, 1 cm long.   Colour of beak and upper portion

of stem rosy, fading almost to white at the base. Ridged portion of gleba red, spaces between ridges deeply sunk and thickly covered with foetid sporiferous mucus. Spores oblong, $7–10 \times 3–4\,\mu$. Volva white, larger and more slender than that of *Mutinus boninensis*, and *M. carninus*.

From its general appearance one might take this fungus for *M. pentagonus* which, as its name implies, is similarly of pentagonal section, but the stem of the latter is of uniform thickness, and there is no beak-like apical process as in the present specimen. *Lysurus Mokusin* also has a pentagonal stem, but has the generic difference of a gleba divided into separate arms corresponding to the ridges of the stem, and also lacks the apical process. The present specimen, because of its beak and undivided gleba, its peculiar hollow ridged pentagonal construction and its distinctive colour scheme, can therefore be easily and sharply distinguished from these or other known fungi, and so recognized as a new species.

Therefore the new name of the present fungus and its description are as follows:

### *Mutinus coracoideus*, KAWAMURA sp. nov.

Volva 4 cm long, 2 cm broad, white, oval, bilobate at apex, springing from a white, cord-like mycelium at the base. Receptacle $14 \times 1$ cm, hollow cellular, pale rosy, fading toward the base where almost white, pentagonal, tapering into an acute and slightly curved apex like the beak of a crow. Gleba-bearing portion situated 1 cm below apex, and receptacle here swollen, strongly fluted, the gleba borne on the channels with reddish free edges. There are no arms; receptacle consists of a single piece. Mucus dark brown, smell strong, very foetid. Spores pale yellowish white, oblong, $7–10 \times 3–4\,\mu$. Found in a garden, Matsudo, Prov. Shimosa, Japan, Nov. 10, 1927.

## V. A New *Geoglossum* Fungus

Last September Dr. KARIYONE made a trip for plant collection on Mt. Mitaké, Prov. Musashi, and he found many fungus specimens which he passed me for identification. Among those specimens I found a new *Geoglossum* fungus. The following description is concerned with it.

## *Geoglossum rotundiformis*, KAWAMURA, sp. nov.

### (Fig. 17–22)

Ascophore glabrous, 4–6 cm high, black ; ascigerous portion about 1/4 of the entire length, roundish, compressed, 1–1.5 cm in diameter, 2 mm in thickness, passing somewhat sharply into the slender, cylindrical blackish stem ; asci clavate, tapering downwards into a long, slender pedicel ; spores 8, arranged more or less parallel near the apex of the ascus, linear-fusiform, ends obtuse, 1–5-septate, mostly 3-septate and brown at maturity, straight or very slightly curved, $70–90 \times 5–6 \mu$ ; paraphyses numerous, faintly septate, $3–5 \mu$ thick, whole part colourless, apex more or less curved ; mixed with the paraphyses, sharp-pointed spines (cystidia), $200–400 \times 6–7 \mu$ which project beyond the asci.   Caespitose on the ground among grass.

Loc. Mitaké, Prov. Musashi.   Collector Dr. T. KARIYONE.
Date Sep. 1927.   Nom. jap. " Tengunoshamoji."



17                                      18            19 20 21
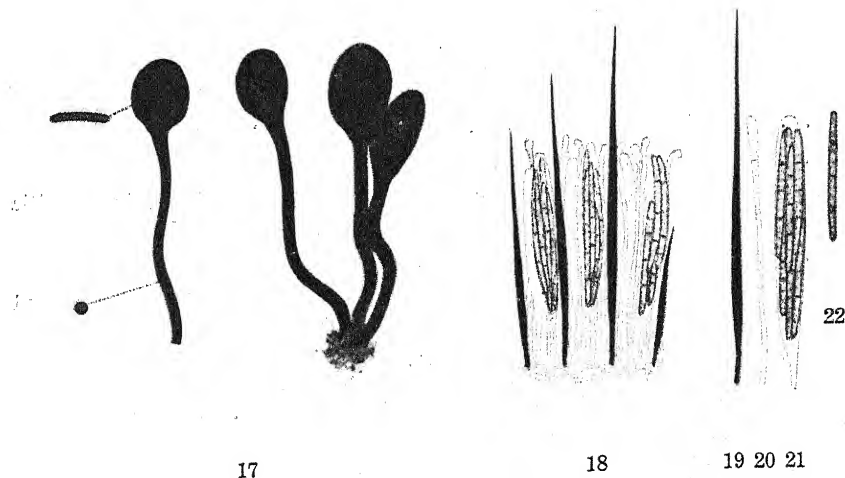
Fig. 17–22

*Geoglossum rotundiformis*, KAWAMURA

17) General feature 2/3.   18) Asciferous layer (200/1).   19) Cystidium (230/1).
20) Paraphysis (250/1).      21) Ascus (250/1).      22) Spore (250/1).

Examination of the hymenium under the loupe reveals long sharp cystidia like those of *G. hirsutum* and *G. Walteri*. But in

these species the spores average $130-150 \times 5\,\mu$ respectively in size, and have an average septation of 15 and of 3-7 respectively, while in the present species the spore size is $70-90 \times 5-6\,\mu$ (about half as slender as the spore of *G. hirsutum*) and the septation 1-5, so that the distinction is easy. *G. glutinosum*, on the other hand, resembles the present fungus in having an average of three septae per spore, but differs in having no cystidia, and in having paraphyses greatly enlarged at the extremity. Note also that this species is of a distinct flattened tadpole shape, while the common species which somewhat resemble it in other respects are more slender and more pointed, and usually have a longer stem. The differential characteristics of this new species thus are: (a) marked hairiness; (b) triseptate brown spores; (c) compressed roundish ascophore.

## Explanation of Plate XXIX

Fig. 1.  " Panther-figured " bamboo.

Fig. 2.  " Tiger-figured " bamboo.

In (1) and (2) the lower portions show natural feature with mycelia of the parasitic fungi, while the upper portions show polished surfaces without mycelia.

Fig. 3.  *Isaria pachylomera*, KAWAMURA.

Left: with spider nest; right: without spider nest, a part of stroma is removed in order to show spider body imbedded in the stroma.

Fig. 4.  *Mutinus coracoideus*, KAWAMURA.

All above are reduced to 2/3 natural size.

PLATE XXIX



1



2



3

$4-5 \times 2\mu$



4

$7-10 \times 3-4\mu$
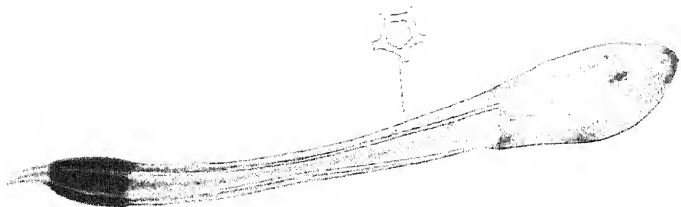
# Über die Resultate der Kreuzung von zwei *Plantago*arten

Von Seiitirô IKENO

Mit drei Textabbildungen

Der gemeine japanische Wegerich, *Plantago major* var. *asiatica*, ist ein in unsrem Lande überall verbreitetes Unkraut, dessen Gestalt und Grösse mit denselben der europäischen *typica*-Sippe fast in völliger Übereinstimmung stehen. Nun begegnet man bei uns, wenn nicht sehr häufig, einer anderen *Plantago*-Sippe, *P. japonica* forma *polystachya* in Kultur. Sie ist von dem gemeinen japanischen Wegerich durch ihre erhebliche Grösse und besonders durch ihren verzweigten Blütenschaft ausgezeichnet: wenn man beide zueinander vergleicht, so sieht man, dass das Blatt von *polystachya*,[1] das seiner Gestalt nach demselben von *major* nicht unähnlich ist, 3–6-mal grösser und viel dicker als dasjenige der letzteren Sippe ist (Abbild. 1, *a* und *b*). Die Hauptähre ist 3–4-mal und derjenige Teil des Blütenschaftes, der keine Blüten trägt, ist 2–3-mal länger bei *polystachya* als bei *major* (vgl. Abbild. 2, *a* und *b*). Bekanntlich ist der Blütenschaft von *major* einfach (Abbild. 2, *a*) und trägt nur eine einzige Ähre, aber derselbe von *polystachya* ist verzweigt, denn es gibt dabei ausser einer Hauptähre noch 3–8 sekundäre Ähren, die viel kürzer sind als die erstere und an ihrem Blütenschaft entwickelt sind, nahe unter der Grenzstelle der blütentragenden und blütenlosen Teile (Abbild. 2, *b*).

Im Sommer 1924 wurde die Kreuzung *polystachya* ♀ × *major* ♂ ausgeführt, wodurch einige Samen vom schlechten Aussehen geerntet wurden, die sich als keimunfähig erwiesen.

Im Sommer 1925 wurde die gleiche Kreuzung wiederholt: eine Anzahl Blüten von *polystachya* wurden sorgfältig kastriert und dann mit dem Pollen von *major* mehrmals bestäubt. Die Erfolge dieser Kreuzungsversuche sind im allgemeinen negativ ausgefallen, bis auf

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(1) Der Kürze halber werde ich unten *Plantago major* var. *asiatica* und *P. japonica* forma *polystachya* durch die verkürzten Namen *major* bzw. *polystachya* nennen.

*a*                     *b*

Abbild. 1

*a*. Blatt von *major*;    *b*. dasselbe von *polystachya*. Verkleinert 5/8.
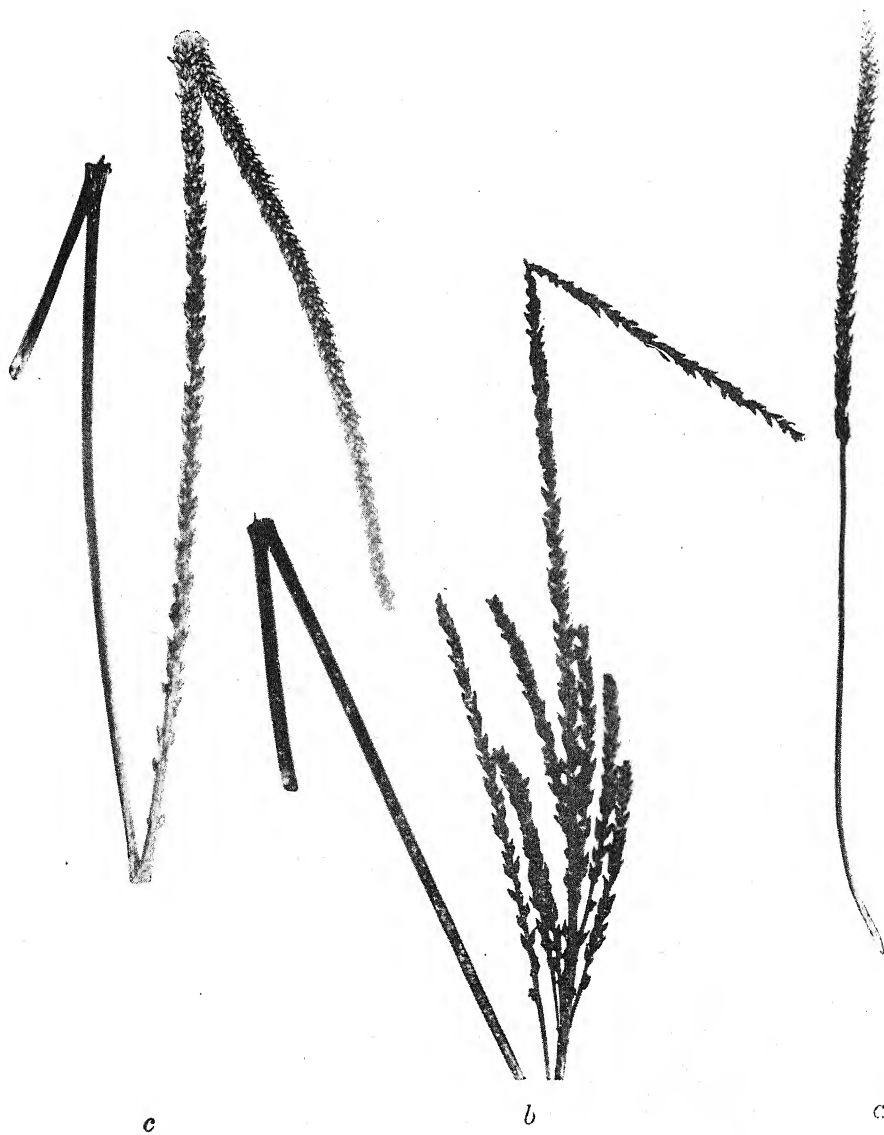
Abbild. 2

*a.* Blütenschaft von *Plantago major* var. *asiatica.*  *b.* Verästelter (normal!) und *c.* Einfacher (abnormal!) Blütenschaft von *P. japonica* forma *polystachya.* Verkleinert ungefähr 2/5.

einige Ausnahmsfälle, wobei einige Kapseln geerntet worden sind. Im Jahre 1926 sind daraus 8 Individuen entwickelt, die wider Erwarten äusserlich ganz der Mutter gleich waren. Alle diese Nachkommen haben sich sehr reichlich fruktifiziert, und indem es nicht ganz ausgeschlossen wäre, wenn nicht sehr wahrscheinlich, dass bei *polystachya* ♀ × *major* ♂ die erstere Sippe in $F_1$ völlig über die letztere dominiere, so habe ich daran eine Anzahl von durch Selbstbefruchtung gebildeten Samen bekommen und sie gesät, woraus 1927 315 Nachkommen hervorgegangen sind. Dabei konnte man gar keine Aufspaltung beobachten, indem alle ausnahmslos mit $F_1$-Individuen, somit mit *polystachya* völlig übereinstimmten.

Im Sommer 1926 wurde die der soeben besprochenen reziproke Kreuzung ausgeführt, nämlich *major* ♀ × *polystachya* ♂. Ebenso wie bei den vorigen Versuchen sind auch hier die Kreuzungen grossenteils misslungen, doch in wenigen Fällen konnte ich einige Samen bekommen, woraus 4 Keimlinge entstanden sind. Sie wuchsen gut und 1927 erwiesen sie sich der Mutter, d.h. *major* völlig gleich zu sein. Eine Anzahl von Samen wurden daran durch Selbstbefruchtung geerntet, und es wurde auch festgestellt, dass alle daraus gekommenen Pflanzen sich konstant verhielten (131 in Zahl), indem sie von *major* gar nicht unterscheidbar waren. Übrigens gab die Rückkreuzung, (*major* ♀ × *polystachya* ♂ $F_1$) × *major* ♂ 65 Pflanzen, die ausnahmslos ganz *major* ähnlich waren.

Fasst man die Resultate der oben besprochenen zweierlei Versuchsreihe zusammen, sind dabei die Kreuzungen grossenteils fehlgeschlagen, doch waren die als die Resultate von wenigen Ausnahmen entstandenen Nachkommen immer der Mutter völlig gleich und übrigens haben sich alle durch Selbstbefruchtung daraus hervorgekommenen Nachkommen konstant erwiesen.

Es frägt sich nun, ob die bei den soeben erwähnten Versuchen entstandenen mütterlichen Individuen nicht die Produkte der des Kastrationfehlers wegen erfolgten unbewussten Selbstbefruchtung seien. Diese Möglichkeit schien mir von vornherein ausgeschlossen zu sein, vor allem wegen der Sorgfalt und Geschicklichkeit unsres Hauptgärtners, Herrn M. ANDÔ, der bei allen diesen Versuchen unter meiner Kontrolle die Kastration vorgenommen hat.[1] Da jedoch

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(1) Die Kastration von *Plantago*-Blüten ist eine äusserst schwierige Aufgabe wegen ihrer extremen Feinheit. Herr M. ANDÔ, unser Hauptgärtner, der während etwas 20 Jahren diese Arbeit bisher jährlich ausgeführt hat, war dabei so geschicklich und so sorgfältig verfahren, dass bei meinen zahlreichen Versuchen über *P. incisa, contracta, contorta, variegata* usw. ich bisher nicht einmal irgend einen wegen ungeschickter Kastration veranlassten Fehler entdecken konnte.

natürlich niemand ohne weiteres behaupten darf, dass die Fehler absolut ausgeschlossen sind, so habe ich im Jahre 1927 ihm beide soeben besprochene Kreuzungen wiederholen lassen, und zwar mit besonderer Sorgfalt angesichts der Gefahr der unbewussten Selbstbefruchtung wegen misslungener Kastration. Leider sind die Kreuzungen *major* ♀ × *polystachya* ♂ negativ ausgefallen (s. Tab. II, S. 309), denn wenn man dabei bisweilen wenige anscheinend gute Kapseln bekommen hat, waren sie ganz leer oder enthalten sie bloss schwarze taube Samen. Dagegen konnte man bei der reziproken Bastardierung, d. h. *polystachya* ♀ × *major* ♂ eine Anzahl von guten Samen ernten (s. Tab. I, S. 308), woraus 11 Pflanzen entwickelt sind, die völlig der Mutter, d. h. *polystachya* glichen. Die Resultate der letzteren Kreuzungen stehen somit mit denselben meiner vorigen in völliger Übereinstimmung und bestätigen die letzteren in schönster Weise.

Aus allen oben geschilderten schliesse ich, dass in unsrem Falle keineswegs von der Selbstbefruchtung die Rede sein kann.

Nun ist die Frage, wie kann man die Produktion mütterlicher Nachkommen in den vorigen Versuchen deuten? Vor allem wird die Vermutung nahe sein, dass dabei wir einen Fall von Parthenogenesis vor uns haben. Um diese Möglichkeit zu prüfen, wurden die Blüten von *major* sowie *polystachya* sorgfältig kastriert, wie folgt: *major* .... 13 Ähren, je 10 Blüten pro Ähre, sodass im ganzen 130 Blüten ; *polystachya* .... 15 Ähren, je 12 Blüten pro Ähre, sodass im ganzen 180 Blüten. Alle kastrierten Blüten wurden vor Bestäubung geschützt. Nun wurden daraus gar keine Samen produziert ; einige anscheinend völlig normale Kapseln erwiesen sich bei näherer Untersuchung keine oder wenige taube Samen zu enthalten (Parthenokarpie). Deshalb wird hier die Parthenogenesis ausgeschlossen sein.

Wenn somit wir keineswegs mit Parthenogenesis im eigentlichen Sinne, d. h. autonomer Parthenogenesis zu tun haben, so doch scheint es mir nicht unwahrscheinlich zu sein, dass hier ein Fall stimulativer Parthenogenesis oder, wie durch FOCKE genannt, Pseudogamie vorliegt, d. h. eine durch die Bestäubung des fremartigen Pollens ausgelöste parthenogenetische Entwicklung.[1] Natürlich wären einige andere Möglichkeiten vorhanden, z. B. die Embryoentwicklung aus der Nuzellarzelle, dieselbe aus der Zentral-

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(1) FOCKE, Die Pflanzen-Mischlinge. Berlin 1881, S. 525.

zelle des Embryosackes usw. Ihre endgiltige Entscheidung dürfte ohne eingehende zytologische Untersuchungen kaum möglich sein, die hier eine grosse Schwierigkeit bieten mögen, weil, wie unten sogleich erläutert, die in Rede stehende Entwicklung sehr selten stattfindet und daher man schwerlich die Materialien im kritischen Zustand bekommen könnte. Die unten zu schildernde Diskussion beruht auf die Annahme der Pseudogamie, die mir in unsrem Falle die wahrscheinlichste zu sein scheint.

Wie oben angedeutet, sind unsre Kreuzungen, entweder *polystachya* ♀ × *major* ♂ oder *major* ♀ × *polystachya* ♂ grossenteils fehlgeschlagen; ausführliches über die Experimente 1927 habe ich in der Tabelle I–II gezeigt.

TABELLE I

Kreuzung *polystachya* ♀ × *major* ♂ (1927)

| Nr. der Kreuzung | Zahl der kastrierten und bestäubten Blüten pro Ähre | | | |
|---|---|---|---|---|
| | positiv | negativ | Summe | % positiv |
| I | 0 | 17 | 17 | 0 |
| II | 2 | 9 | 11 | 18,2 |
| III | 2 | 11 | 13 | 15,4 |
| IV | 2 | 7 | 9 | 22,2 |
| V | 3 | 17 | 20 | 15,0 |
| Summe | 9 | 61 | 70 | 14,2 (= Mittel) |

## TABELLE  II

### Kreuzung  *major* ♀ × *polystachya* ♂  (1927)

| Nr. der Kreuzung | Zahl der kastrierten und bestäubten Blüten pro Ähre | | | |
|:---:|:---:|:---:|:---:|:---:|
| | positiv | negativ | Summe | % positiv |
| I | 0 | 14 | 14 | 0 |
| II | 0 | 18 | 18 | 0 |
| III | 0 | 11 | 11 | 0 |
| IV | 0 | 12 | 12 | 0 |
| V | 0 | 12 | 12 | 0 |
| Summe | 0 | 67 | 67 | 0(=Mittel) |

In der Tabelle I–II zeigt die Ziffer in der Kolumne "positiv" und "negativ" die Zahl von positiv bzw. negativ ausgefallenen Versuchen bei jedem Nr. Kreuzung.

Bezüglich der Kreuzung *polystachya* ♀ × *major* ♂ sind, wie man in Tab. I sieht, unter 70 Bestäubungen 61 erfolglos (d. h. 86%) und nur an 9 Blüten konnte man die Früchte ernten (=ungefähr 14%). Weiter, alle Versuche, *major* ♀ × *polystachya* ♂ waren ausnahmslos erfolglos (Tab. II); dass diese letztere Tatsache keine absolute, sondern bloss zufällige ist, ist ohne weiteres klar aus den Resultaten der 1926 ausgeführten derselben Kreuzungen, denn, wie man schon gesehen hat (S. 306), sind damals 4 Pflanzen entstanden, die ganz mütterlich sind.

Aus allen oben geschilderten kann man zur folgenden Annahme geführt werden: das Pollen von *polystachya* ist unfähig, die Eizelle von *major* zu befruchten, doch fähig, sie zur weiteren Entwicklung anzuregen, gleichfalls wie z.B. in gewissen Fällen die Eizellen durch die Reizwirkung von chemischen Substanzen usw. sich zu entwickeln veranlasst werden können. Ganz dasselbe Verhältnis besteht zwischen dem Pollen von *major* und der Eizelle von *polystachya*. Kurz, die Artkreuzung zwischen *polystachya* und *major* ist unmöglich; die daraus sehr selten hervortretenden Pflanzen stellen gar keine Kreuzungsprodukte dar, sondern sie sind bloss durch den Reiz des

fremdartigen Pollens entstanden, ohne dass der eigentliche Befruchtungsvorgang darin beteiligt ist (Pseudogamie !)

Hier möge es mir gestattet sein, eine kurze Vergleichung zu machen zwischen den an *Plantago* erhaltenen obigen Resultaten und denselben, die ich 1922 bezüglich einigen *Salix*arten veröffentlicht hatte.[1] Bei *S. multinervis* nämlich habe ich nachgewiesen, dass die Kreuzung derselben ♀ durch eine andere Art, *S. gracilistyla* ♂ bisweilen die Bastarde, bisweilen die ganz der Mutter gleichen Nachkommen entstehen liess. Die letztere Erscheinung wurde auf Pseudogamie zurückgeführt. Auch wurde es fernerhin bei *multinervis* beobachtet, dass höchst selten sogar die autonome Parthenogenesis stattfinden kann.[2]

Die oben beschriebenen Erscheinungen an *Plantago*arten stimmen mit denen, was man bei *Salix* wahrgenommen hat, vor allem darin überein, dass in beiden die Entwicklung durch Pseudogamie geschehen kann. Beide unterscheiden sich doch voneinander darin, dass während die Eizelle von *multinervis* durch das Pollen von *gracilistyla* befruchtet werden kann (Bastardbildung !), die Befruchtung zwischen beiden in Rede stehenden *Plantago*arten niemals nachgewiesen worden ist.[3] Der weitere Unterschied, der im obigen

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(1) Ann. Bot. **36**, 1922, S. 175 ff.
(2) IKENO l.c., S. 184 ff.
(3) Es wird kaum nötig sein, besonders zu erwähnen, dass bei dieser Erfolglosigkeit der Befruchtung die Unverträglichkeit zwischen den Gameten von zwei Wegericharten schuldig ist. Dass die *major*-Pflanze durch die dazu verträglichen Sippen sehr gut kreuzen lässt, kann man aus meinen Kreuzungsversuchen an verschiedenen *Plantago*sippen sehen. Die folgenden Resultate der 1927 ausgeführten Kreuzungen mögen noch zur Erläuterung dieser Tatsache dienen. Die 5 *major*-Individuen, die die Schwesterpflanzen der bei der Kreuzung mit *polystachya* gebrauchten sind, wurden durch *pseudocontorta*, die äusserlich linksgewunden sind (s. IKENO, Japan. Jour. Bot. **1**, 1923, S. 175) bestäubt und siehe die Ergebnisse :

TABELLE III

| Nr. der Kreuzung | Zahl der kastrierten und bestäubten Blüten pro Ähre | | | |
|---|---|---|---|---|
| | positiv | negativ | Summe | % positiv |
| I | 16 | 2 | 18 | 88,9 |
| II | 6 | 9 | 15 | 40,0 |
| III | 15 | 5 | 20 | 75,0 |
| IV | 11 | 5 | 16 | 68,7 |
| Summe | 48 | 21 | 69 | 68,2(= Mittel) |

Die positiven Erfolge betragen 68,2 %, was in diesem Falle wohl als das Resultat sehr gut gelungener Versuche betrachtet werden kann, angesichts der Schwierigkeit der Operation.

zwischen *Salix* und *Plantago* vorhanden zu sein bezeichnet wurde, bestand darin, dass während bei der ersteren äusserst selten die autonome Parthenogenesis beobachtet werden konnte, sie niemals bei der letzteren angetroffen wurde. Dieser Unterschied dürfte jedoch vielleicht nur scheinbar sein, und höchst wahrscheinlich mögen meiner Ansicht nach die weiteren eingehenden Experimente auch bei *Plantago* wenige Fälle von autonomer Parthenogenesis entdecken. Wie schon oben erläutert (S. 307), wurden bei meinen Versuchen an *Plantago* im ganzen 130+180=310 Blüten kastriert. Als diese Arbeit nicht nur sehr zeitraubend, sondern auch höchst mühevoll ist, war es mir unmöglich, eine noch grössere Anzahl von Blüten zum Versuche zu nehmen. Angesichts der grossen Schwierigkeit der Kastrationsoperation von feinen *Plantago*blüten ist, wie ich glaube, die Zahl 310 ziemlich gross zu nennen, doch ist sie verschwindend klein im Vergleich zu 2503×100=250 300 Blüten von *multinervis*, die zum Versuche benutzt worden sind.[1] Und dennoch hat man im letzteren Falle bloss 4 Samen bekommen (=0,0015%), trotzdem eine so kolossale Menge von Blüten untersucht worden sind. Hätte man auch bei *Plantago* eine ebenso grosse Zahl von Blüten kastrieren können, so könnte der Nachweis autonomer Parthenogenesis in wenigen Fällen nicht unwahrscheinlich sein, wenn die Tatsache natürlich ohne weiteres noch unentschieden bleibt.

Unten möchte ich einiges über die Chromosomenverhältnisse unserer Wegericharten mitteilen. Herr Dr. Y. SINOTÔ war so liebenswürdig, als er die Chromosomenzahl der von mir zur Untersuchung genommenen Gewächse zählte und übrigens die an S. 312 befindliche Abb. 3 zeichnete, wofür ich hier ihm meinen herzlichsten Dank erstatten möchte. Abb. 3, *a* und *b* zeigen die Chromosomen in der Wurzelspitze von *polystachya* und *major*, die 36 bzw. 24 betragen. In Abb. *c* werden die Chromosomen in der Wurzelspitze von *polystachya* ♀ × *major* ♂ F₁ dargestellt: ihre Zahl stimmt genau mit derselben der Mutterpflanze überein (=36), auch sind sie ihrer Gestalt nach derjenigen der letzteren ähnlich. Die sog. F₁-Pflanze hier enthält demnach die somatische Zahl der Chromosomen von *polystachya*, weshalb das Resultat der Kreuzung *polystachya* ♀ × *major* ♂ eine F₁-Pflanze ist, die nicht nur äusserlich, sondern auch innerlich der Mutterpflanze gleicht. Indem im vorliegenden Falle

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(1) 2503 Kätzchen und bei jedem 100 Blüten im Mittel, sodass im ganzen 250 300 Blüten. Kaum nötig dürfte es sein zu erwähnen, dass bei *Salix* das blosse Einschliessen von weiblichen Blüten im Pergaminbeutel genügt, um sie vor Bestäubung zu schützen. Siehe IKENO, Ann. Bot. **36**, S. 185.

die dank Pseudogamie produzierten Pflanzen die somatische Chromo-
somenzahl der Mutter enthalten, haben wir hier einen Fall "soma-



c
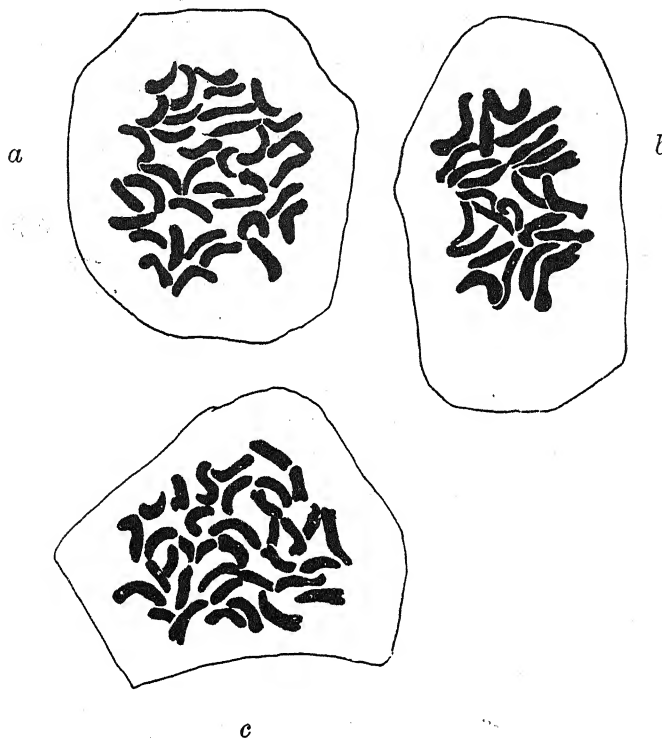
**Abbild. 3**
Alle 2800-mal vgr. Für Figurerklärung siehe den Text (nach SINOTÔ)

tischer Parthenogenesis," wie von WINKLER genannt,[1] vor uns.

Die nächste Frage wird lauten: Wie kann man das obige
Verhalten der sog. $F_1$-Pflanze deuten? Hat dabei das normale mit
der Reduktionsteilung verbundene Gametenbildung stattgefunden?
Oder sind die $F_1$-Pflanzen ohne solch einen Vorgang zustande ge-
kommen?

Vor allem ist es zu betonen, dass bei der Gametenbildung von
*major* in der Regel am wenigsten die Reduktionsteilung sicher
eintreten wird. Bei meinen früheren Kreuzungsuntersuchungen
zwischen *major* und verschiedenen anderen Sippen[2] habe ich in $F_2$

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[1] Parthenogenesis und Apogamie im Pflanzenreiche. Jena 1908, S. 71.
[2] IKENO, Jap. Jour. Bot. **1**, 1923, S. 153 ff., s. auch IKENO, Bibliographia Gene-
tica **3**, 1927, S. 314 ff.

die typische MENDELsche Aufspaltung festgestellt. Nun spricht die soeben erwähnte Spaltungserscheinung entschieden für das Eintreten der Reduktionsteilung bei der Gametenbildung, denn ohne solch einen Vorgang muss die beobachtete Spaltung unverständlich sein.

Wie kann man denn die Produktion der Nachkommen mit somatischer Chromosomenzahl in dem vorliegenden Fall deuten? Um diese Tatsache aufzuklären, kann man z. B. annehmen, dass wenn bei *polystachya* sowie *major* die Eimutterzellen in der Regel der Reduktionsteilung unterworfen werden, um folglich die normalen Gameten mit reduzierter Chromosomenzahl entstehen zu lassen, doch in seltenen Fällen wenige Eimutterzellen ohne vorher keine Reduktionsteilung zu erfahren sich direkt zu den Eizellen entwickeln können und demnach mit somatischer Chromosomenzahl ausgestattet sind. Daher kommen beide Arten Eizellen, nämlich dieselben mit unreduzierter und reduzierter Chromosomenzahl zugleich an einer und derselben Pflanze vor, was gerade auch man bei gewissen parthenogenetischen oder pseudogametischen Arten von *Thalictrum*,[1] *Hieracium*,[2] *Rubus*[3] [4] und *Salix*[5] beobachtet oder angenommen hatte.[6] Die Vermutung wird dann nahe sein, dass in unsrem Falle die normalen Gameten ohne Befruchtung nicht entwicklungsfähig sind, während wenige mit somatischer Chromosomenzahl bloss durch die Reizwirkung des fremartigen Pollens zur Entwicklung angeregt werden können. Unsre sog. $F_1$-Pflanzen werden daher zur letzteren der obigen zwei Klassen gehören. Die Tatsache, warum unsre Kreuzungen grösstenteils fehlgeschlagen sind, dürfte auf diesem Grunde leicht verständlich sein, weil die Zahl von Gameten mit somatischer Chromosomenzahl gegenüber derselben von normalen verschwindend klein sein muss. Bei meinen zahlreichen Kreuzungen zwischen *major* und verschiedenen anderen Sippen (*incisa, contracta, contorta, variegata*)[7] habe ich, wie soeben angedeutet, in $F_2$ die Zahlenreihe bekommen, die auf die typische MENDELsche Aufspal-

(1) OVERTON, Ber. Deutsch. Bot. Ges. **22**, 1904, S. 274 ff.

(2) ROSENBERG, Bot. Tidssk. **28**, 1907, S. 143 ff.

(3) Zeit. ind. Abstamm. u. Vererb. lehre **12**, 1914, S. 1 ff.

(4) BAUR, Einführung in die experimentelle Vererbungslehre 2–3. Aufl. Berlin 1919, S. 258.

(5) IKENO, Ann. Bot. **36**, S. 255 ff.

(6) Ob bei *Plantago* eine mit Aposporie verknüpfte somatische Parthenogenesis, wie es bei gewissen *Hieracium*arten der Fall ist (ROSENBERG, l.c.) vor uns liegt, ist eine weitere Frage.

(7) IKENO, l.c. (s. S. 312 des vorliegenden Aufsatzes, Fussnote).

tung hinweist. Es wäre nicht ausgeschlossen, dass dabei unter den herausgespalteten *major*-Individuen wenige aus den Gameten mit somatischer Chromosomenzahl hervorgegangenen Zygoten sich befänden. Dass nichtsdestoweniger das Zahlenverhältnis der herausgespalteten $F_2$-Nachkommen nicht bedeutend aus der theoretischen abweicht, ist leicht begreiflich, denn solche abnormale Zygoten sind zu wenig vertreten, um merkwürdigerweise das typische Verhältnis stören zu können.

Oben haben wir die Annahme gemacht, dass die Gameten mit reduzierter und unreduzierter Chromosomenzahl an einer und derselben Pflanze zugleich vorkommen. Nun bezüglich der Deutungsweise der Entstehung von *Plantago*-Individuen wäre ausser der soeben besprochenen eine andere Alternative möglich, wobei man nicht anzunehmen braucht, dass die Gameten einer und derselben Pflanze teils mit unreduzierter und teils mit reduzierter Chromosomenzahl ausgestattet sein sollen. Dabei nimmt man an, dass alle Eizellen nach der normalen Reduktionsteilung entstehen und der Entwicklung solcher haploiden Eizellen die Verdoppelung der Chromosomenzahl bald nachfolgt. Im betreff der Frage, wie der letztere Vorgang zustande kommen wird, gibt es verschiedene denkbare Wege. Z. B. hat neuerdings Jørgensen[1] bei seinem Kreuzungsversuche, *Solanum nigrum* ♀ × *S. luteum* ♂ die mütterlichen $F_1$-Pflanzen erhalten, die die diploide Chromosomenzahl der Mutter (=72) enthalten. Der dänische Forscher hat diese Tatsache durch die Annahme zu deuten versucht, dass eine solche Pflanze aus einer nach Reduktionsteilung erzeugten haploiden Eizelle entstanden sei, insofern als die letztere eine Kernteilung erfährt, ohne durch die Zellmembranbildung nachgefolgt zu werden werden und im nächsten Stadium die Verschmelzung von zwei Kernspindeln erfolgt ("Endoduplikation.") Diese Hypothese bleibt doch noch ganz unbewiesen.

Wir haben oben gesehen, dass nicht nur die Eizelle von *polystachya* durch das Pollen von *major* zur weiteren Entwicklung angereizt wird, sondern auch der umgekehrte Vorgang stattfinden kann. Man kann fragen: wird es nicht möglich sein, dass die Eizelle von diesen zwei Wegericharten durch das Pollen von anderen systematisch dazu mehr oder minder verwandten Pflanzenarten zur Entwicklung gebracht werden könne, wie es tatsächlich bei der Eizelle von *Zygopetalum Mackayi* der Fall war, die durch das Pollen

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(1) Jour. Gen. **19**, 1928, S. 133 ff.

der zu anderen Orchideengattungen (wie *Odontoglossum, Lycaste, Laelia, Calanthe, Vanilla*) gehörenden Arten zur Entwicklung angeregt wurde.[1]

Die Entscheidung dieser Frage ist natürlich möglich, wenn z. B. das Pollen verschiedener *Plantago*arten reichlich zur Verfügung steht. Im Oktober dieses Jahres (1928) konnte ich bloss für das betreffende Experiment das Pollen von *P. lanceolata* benutzen : ich habe eine grosse Anzahl (ung. 150) von *major*-Blüten kastrieren und dieselben durch das Pollen von *lanceolata* bestäuben lassen. Wenn dabei fast alle Versuche negativ ausgefallen sind, habe ich doch unter anderen am wenigsten einen reifen Samen von sehr gutem Aussehen bekommen.[2] Ich beabsichtige im nächsten Jahre die weiteren diesbetreffenden Bestäubungsversuche auszuführen.

Hier möchte ich hinzufügen, dass auch bei gewissen Artkreuzungen von *Nicotiana*[3] und *Brassica*[4] ganz dieselbe Erscheinung wie die soeben geschilderte, d. h. die Produktion der Nachkommen, welche sowohl ihrer Gestalt als Chromosomenzahl nach völlig mütterlich sind, nachgewiesen worden ist, wenn ob sie zur Pseudogamie oder zu irgend anderer Ursache zurückzuführen ist, noch unentschieden bleibt.[5]

Zum Schlusse möchte ich eine merkwürdige Beobachtung über *polystachya* erwähnen. Der Name *polystachya* rührt von dem verzweigten Charakter der Blütenschaften bei dieser Sippe her. Die langjährige Kultur derselben in hiesigem Botanischen Garten hat uns von der völligen Konstanz dieses Merkmales überzeugt, doch hat die Beobachtung im Hochsommer 1928, besonders im August, uns gezeigt, dass diese Konstanz keineswegs unveränderlich ist, denn die Blütenschaften, die im August dieses Jahres zur Entwicklung angekommen sind, fast sämmtlich einfach waren, statt verzweigt zu sein, im auffallendem Gegensatz zu dem, was man bisher dabei nachgewiesen hatte (Abb. 2, vgl. *b* und *c*). Diese Ausnahmeerscheinung ist, wie ich glaube, höchstwahrscheinlich der abnormen Sommernässe 1928 zu verdanken. Sowohl in der letzten Hälfte Julis

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(1) HURST, Experimente in Genetics 1925, S. 135 ff.
(2) Dieser Samen wurde zum Ende November ausgesät, doch kommt er noch nicht zur Keimung. (Ende Dezember 1928).
(3) Bibliographia Genetica **4**, 1928, S. 277.
(4) Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. (Biol.) **4**, 1928, S. 830 u. 838.
(5) Ganz neuerdings hat NOGUCHI bei einer Artkreuzung von *Brassica* dieselbe Erscheinung beobachtet. Seiner Ansicht nach ist sie als Pseudogamie zu deuten und er hat sie auf zytologischem Wege zu erklären versucht (Proc. Imp. Acad. **4**, 1928, S. 617 ff.).

als im ganzen August ist in Tôkyô das Wetter in der Regel trocken,
da zu dieser Zeit das Wetter immer schön zu sein pflegt, ausgenom-
men das gelegentliche Vorkommen des Gewitters, der höchstens nur
einige Stunden dauern wird.    Im August 1928 war es dagegen äu-
sserst nass, denn fast jeder Tag regnete es sich, was einen sehr
seltenen Ausnahmefall bei unserer Klima bildet, der vielleicht nur
einmal pro zwanzig Jahren oder sogar noch seltener stattfinden
könnte.  Die Vermutung liegt es somit sehr nahe, dass der Einfach-
heit der Blütenschaften bei *polystachya* diese abnorme grosse Feuch-
tigkeit zu Grunde liegt, wenn ob die letztere direkt die Verzweigung
der Blütenschaften mehr oder minder verhindern kann, oder indirekt
durch eine Kette von intermediären Vorgängen zu diesem Resultate
führen kann, noch unentschieden bleibt.  Die folgenden Beobach-
tungen dürfen von Interesse sein, um die soeben erörterte Annahme
zu unterstützen.  Bei denselben Individuen, von denen die im August
produzierten Blütenschaften einfach waren, waren diejenigen, die
in der letzten Hälfte Junis und in der ersten Hälfte Julis entwickelt
sind, verzweigt wie üblich ; in diesem Zeitraum—Juni-Juli—war das
Wetter nicht besonders von dem gewöhnlichen verschieden, d. h.
weder sehr trocken noch sehr feucht.  Weiter, bei den Individuen,
die erst im Anfang Septembers 1928 die Blütenschaften zu produ-
zieren begannen, waren die letzteren verzweigt und das Wetter war
zu dieser Zeit ziemlich trocken.

Alle oben geschilderten sind naturlich die aus den beobachteten
induzierte blosse Vermutung und ich werde im nächsten Sommer
einige Experimente darüber ausführen, um sie sicherstellen zu kön-
nen.  Es ist hinzuzufügen, dass trotz der einfachen Blütenschaften
die Zugehörigkeit der Pflanzen zur Sippe *polystachya* kaum bezwei-
felt werden kann, wegen der Grösse der Blütenschaften und Be-
schaffenheit der Blätter.  Die nach der Kreuzung *polystachya* ♀ ×
*major* ♂ produzierten Nachkommen ($F_1$ und $F_2$) verhielten sich in
dieser Hinsicht ganz gleich, indem ihre Blütenschaften bisher immer
verzweigt waren und erst im August 1928 die einfachen erschienen
sind.

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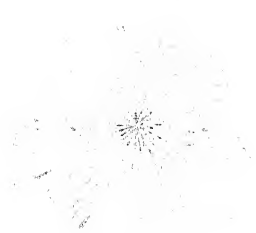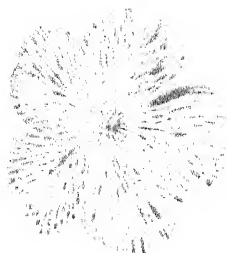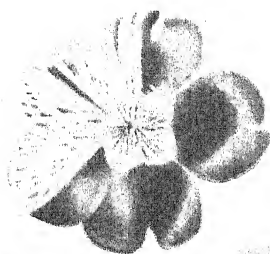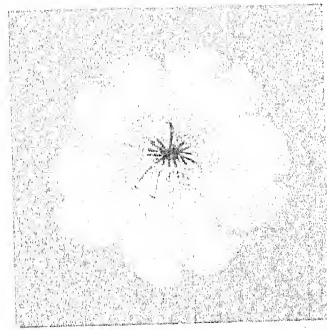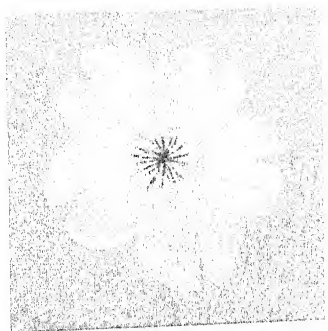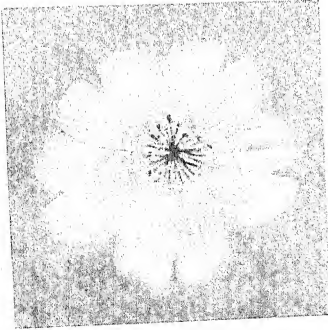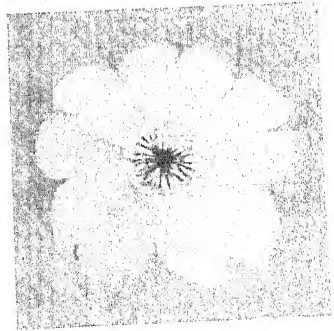
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# Embryologische Studien an der Gattung
## *Chrysanthemum*

Von Shinkichi TATEISHI

### Inhaltsverzeichnis

## Einleitung

Bisher sind ziemlich viele embryologische und zytologische Studien an den Kompositen veröffentlicht worden, so z.B. die von PALM, B. (1915), TAHARA, M. (1921), DAHLGREN, K. V. O. (1920, 1924), AFZELIUS, K. (1924), u.a., um nur die relativ neu erschienenen Forschungen über die Embryosäcke der Kompositen und die damit in direkter Beziehung stehenden hervorzuheben.

Was in der Struktur des Embryosackes der Kompositen besondere Aufmerksamkeit erregt, dürften wohl dessen ungewöhnliche Antipoden sein. Die Ansichten der Forscher, die sich mit der Vermehrung derselben beschäftigt haben, zerfallen im grossen und ganzen in zwei Parteien: die eine will die so ungewöhnlich vermehrten Antipoden von irgend welchen Megasporen hergerührt sehen, während die andere meint, sie seien auf die eigentlichen Antipoden zurückzuführen. AFZELIUS hat in seiner Forschung über die Embryologie von *Senecio* und verwandten Gattungen dieser Erscheinung besondere Aufmerksamkeit gewidmet, er gibt dabei an, dass die Antipodenvermehrung dieser Pflanzen überhaupt von eigentlichen Antipoden ausgehe. Indessen ist

über den Embryosack der *Chrysanthemum*-Arten, wovon hier die Rede sein soll, keine eingehende Beschreibung vorhanden. Daher kommt es wohl, dass man in dieser Hinsicht sehr wenig weiss über diese Gruppe Pflanzen, welche sehr oft in Japan kultiviert werden; besonders ausgezeichnet ist darunter *Ch. morifolium* var. *sinense* durch seine in
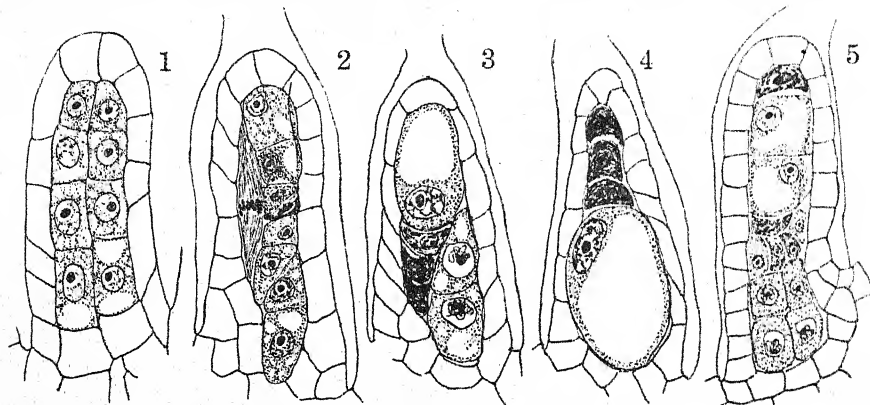


Textfig. 1–4. *Chrysanthemum leucanthemum*. 1. Der junge Nuzellus mit zwei Reihen linear geordneter Tetraden. 2. Zwei Reihen der Tetraden und eine Embryosackmutterzelle im Stadium der heterotypischen Metaphase. 3. Im Entwicklung begriffene mikropylare Zelle und zwei Embryosackmutterzellen. 4. Die chalazale Makrospore zum Embryosack auswachsend. 5. *Ch. morifolium* var. *sinense*, zwei Tetraden und vier Embryosackmutterzellen. (Vergr. 300).

sehr alte Zeit zurückgehende Geschichte der Zucht, dessen Gartenvarietäten mithin eine grosse Anzahl erreichen. Der Verfasser ging also mit der Vermutung an die Arbeit heran, dass sein Embryosack— insbesondere dessen Antipoden, welche höchst schwankend sein dürften —wie seine äusserlichen Veränderungen mannigfaltig sind, so auch verschiedene Variationen erfahren würde.

Als Fixierungsmittel wurde vorwiegend GILSON's Flüssigkeit benutzt, die ein gutes Resultat zu ergeben scheint. Zum Färben wurde hauptsächlich HEIDENHAIN's Eisenalaunhämatoxylin verwendet.

Bei dieser Gelegenheit spreche ich Herrn Prof. M. ISHIKAWA meinen herzlichsten Dank aus, der mir bei diesen Studien mit Tat und Rat beigestanden hat.

## Die Entwicklung des Embryosackes

Nach der Angabe Prof. TAHARA's [1] über die *Chrysanthemum*-Arten ist die Zahl der in jedem Nuzellus enthaltenen Embryosackmutterzellen

(1) TAHARA, M. (1921). Cytologische Studien an einigen Kompositen. Jour. Coll. Sc. Imp. Univ. Tokyo Bd. **43**, S. 11.

unbeständig, also bald nur eins (*Ch. nipponicum, Ch. decaisneanum*),
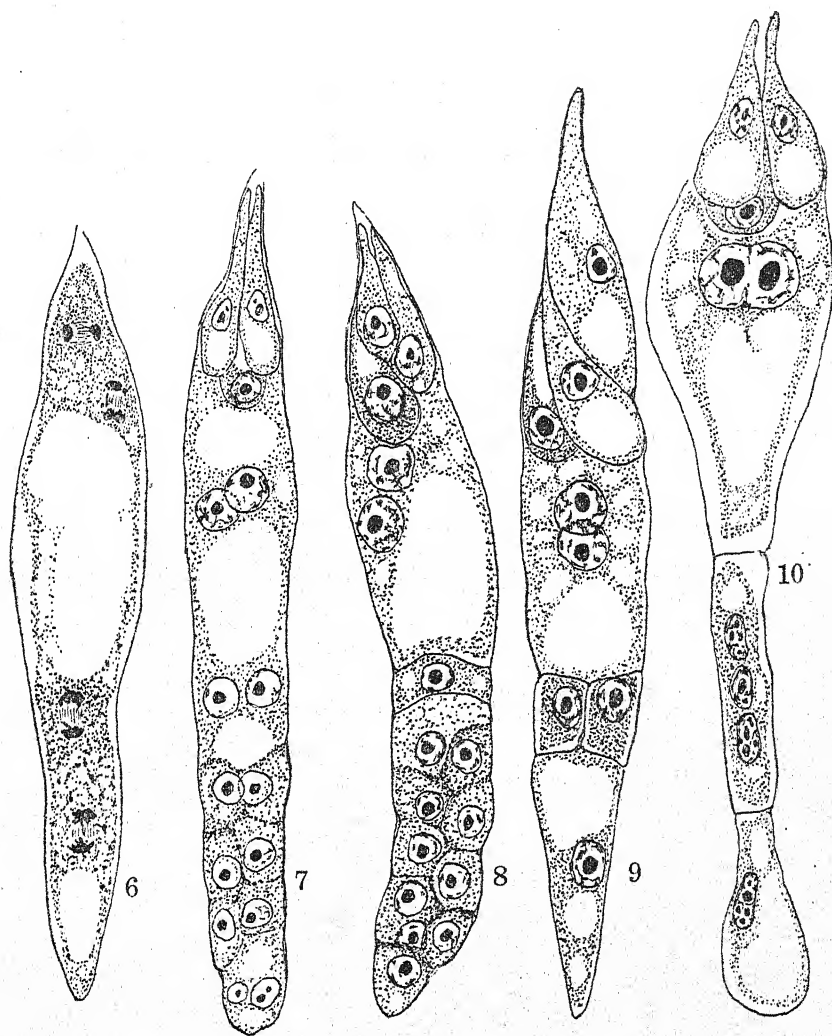


Textfig. 6. *Ch. indicum* var. *hibernum*. Dritte Teilung des jungen Embryo-sackes (vergr. 430). 7–9. *Ch. parthenium* (vergr. 600). 7 u. 8. Die Säcke mit 10 bez. 12 Antipodenkernen. 9. Dieselben mit 3 Antipoden, die beiden oberen neben-einander liegend. 10. *Ch. leucanthemum* (vergr. 430). Befruchtungsreifer Embryosack mit 2 Antipoden.

bald etwa bis zehn (*Ch. roseum*). Das Resultat meiner Untersuchung ist folgendes.

| Pflanzennamen | Zahl der E.M.Z. in jedem Nuzellus |
|---|---|
| *Ch. morifolium* var. *sinense* | 1 — 6 |
| *Ch. lavandulaefolium* var. *typicum* | 1 — 3 |
| *Ch. decaisneanum* var. *radiatum* f. *satsumense* | 1 — 2 |
| *Ch. indicum* | 1 — 2 |
| *Ch. indicum* var. *hibernum* | 1 — 2 |
| *Ch. parthenium* | 1 — 2 |

Wie die Tabelle zeigt, sind die Fälle überwiegend gross, in welchen mehr als zwei Embryosackmutterzellen in einer Samenanlage sich befinden, während es auch solche nicht mangeln, wo nur je eine Zelle vorhanden ist. Damit ist es also festgestellt, dass unter den allgemein bekannten 15 Arten dieser Gattung 13 oft wenigstens über zwei Embryosackmutterzellen haben, eine Tatsache, die in irgend einer Beziehung zu der beim Nuzellus dieser Gattung häufig eintretenden Verdoppelung des Embryosackes, wovon später noch die Rede sein wird, stehen mag.

Jede Embryosackmutterzelle entwickelt sich meistens zu linear geordneten Tetraden, wovon die Makrospore am chalazalen Ende Embryosack wird (Textfig. 4). Das aber ist nicht immer entschieden, es kann auch vorkommen, dass die am mikropylaren Ende zum Embryosack heranwächst (Textfig. 3). Zu konstatieren, bis zu welchem Grade in dem Falle, wo in einem einzelnen Nuzellus zahlreiche Embryosackmutterzellen sich befinden, jede derselben ihr Wachstum fortsetzt, wird wohl jederman sofort einfallen. DAHLGREN (1920) hat an *Chrysanthemum corymbosum* beobachtet, dass viele Mutterzellen fast gleichmässig zu Tetraden gebildet sind. Auch an *Ch. leucanthemum* können mitunter 2 oder 3 Reihen linear geordneter Tetraden gesehen werden (Textfig. 1, 2), was freilich nicht anders zu betrachten ist als Resultat der fast gleichzeitigen Reduktionsteilung der massenhaften Makrosporen. Sonst weisen sie verschiedene Entwicklungsstadien auf; bei *Ch. leucanthemum* und *Ch. morifolium* var. *sinense* u.a. wurde es nämlich beobachtet, dass eine Spore schon eine Tetrade ist, während die andere noch etwa Prophase der heterotypischen Teilung darstellt (Textfig. 2 u. 5). In dem Falle, wo die Entwicklungstadien nicht gleichmässig sind, würde die Spore, welche zuerst die Reduktionsteilung ausgeführt hat, sich zu entwickeln beginnen. Es ist aber nicht völlig ausgeschlossen, dass einige Embryosackmutterzellen gleichzeitig ein gewisses Entwicklungsstadium erreichen. Bei *Chrysanthemum*-Arten sieht man oft in einem einzigen Nuzellus ausser einem reifen Embryo-

sack noch einen von mangelhafter Entwicklung. Dies deutet wohl darauf hin, dass der letztere aus der etwas später an die Entwicklung eintretenden Mutterzelle herrührt.

Mit der Vergrösserung des einzelligen Embryosackes tritt die Degeneration der sterilen Schwesterzellen ein, indem auch das Gewebe des Nuzellus aufzulösen beginnt und ehe noch der Kern des Embryosackes sich in zwei teilt, erleidet der Nuzellus meist eine Pyknose. Daher bleibt beim reifen Embryosacke nur noch etwas Rest des Nuzellus nahe an beiden Enden übrig, und der Sack kommt direkt an die Innenseite des Integumentes, nämlich an die Tapetenschicht zu liegen. Beim Zweikernestadium vakuolisiert der Sack wie normal, verlängert sich plötzlich in Längsrichtung, um dann vierkernig zu werden. Die 4 Kerne ordnen sich in Längsrichtung an, die 2 am Chalazalende sind mitunter durch die neu entstandenen Vakuolen getrennt, was auch bei den 2 am Mikropylende nicht der Fall ist. Bei der dritten Teilung ist die Polarität immer ausschlaggebend. Nur ein Kern, welcher der Mikropyle am nächsten liegt, teilt sich rechtwinklig gegen die Längsrichtung des Sackes, die so geteilten Kerne werden später zwei Synergiden und die übrigen drei Kerne teilen sich in Längsrichtung (Textfig. 6, Taf. XXX, Fig. 2). Die Entstehungsweise ist in dieser Hinsicht ganz identisch mit der der meisten lang und schmalen Embryosäcke und stimmt mit der Beobachtung von Tahara (1921) bei *Erigeron annuus* und von Afzelius (1924) bei *Emilia sagittata* überein.

## Die Ausbildung des jungen Embryosackes und der reife Embryosack

Was die Ausbildung des jungen achtkernigen Embryosackes betrifft, so steht das Ergebnis meiner Untersuchung fast im Einklang mit der Angabe von Afzelius (1924) über *Senecio* und verwandte Gattungen. Der Embryosack ist anfangs lang und schmal und stellt eine richtige Spindel dar, dann wird er, nachdem die Polkerne verschmolzen sind, durch die zunehmende Breite seines oberen Teils keulenförmig, wie dies bei Kompositen allgemein der Fall ist. Den befruchtungsreifen Embryosack angehend, so haben die beiden Synergiden einen sehr lang und schmalen Oberteil, der in die Mikropyle hineingedrungen ist und dessen Spitze kein besonderes Aussehen bietet. Es fehlt ihnen aber der Fadenapparat, wie man ihn bei anderen Pflanzen vielfach beobachtet hat. Die Eizelle zeigt eine etwas dick und kurze, umgekehrte

Keulenform, und ist oben mit grossen Vakuolen versehen, wodurch die
grossen Kerne und dickflüssiges Plasma wie nach unten gedrängt aus-
sehen. Kurz, man könnte bei dieser Gattung betreffs des Eiapparates
und der Polkerne nahezu von einem musterhaften Typus des normalen
achtkernigen Embryosackes sprechen.

## Ueber den basalen Teil des Embryosackes

Die Antipodenvermehrung ist schon von DAHLGREN (1920) bei
*Ageratum*, *Aster*, *Helichrysum*, *Tussilago*, etc., von PALM (1914) bei
*Bellis*, von TAHARA (1921) bei *Erigeron dubis* und *E. linifolius*, von
AFZELIUS (1924) bei *Senecio* und verwandten Gattungen beschrieben
worden. Dabei ist mitgeteilt, dass die Antipoden der betreffenden
Gattung oft mehrkernig sind und mitunter Kernverschmelzen durch-
gemacht haben.

Der Verfasser hat an einer ganzen Reihe von *Chrysanthemum*-
Arten (*Ch. coronarium*, *Ch. decaisneanum* var. *radiatum* f. *satsumense*,
*Ch. frutescense*, *Ch. indicum*, *Ch. indicum* var. *hibernum*, *Ch. japoni-
cum*, *Ch. lavandulaefolium* var. *typicum*, *Ch. leucanthemum*, *Ch. mori-
folium* var. *genuinum* f. *japonense*, *Ch. parthenium*) und der Garten-
varietäten von *Ch. morifolium* var. *sinense* der Konstruktion des
basalen Teiles des Embryosackes besondere Aufmerksamkeit geschenkt.
Im allgemeinen sind die Antipoden der erwähnten Pflanzen nicht
normal, die Zahl der Zellen beträgt entweder mehr oder weniger als
drei, während diese gewöhnlich drei zählen. Auch die Anzahl und
Gestalt der Kerne, die sich in einer Zelle finden, sind abnorm. Die
Anordnung der Zellen ist sehr unregelmässig, keine Gattung lässt sich
darin einheitlich bestimmen; bei einer Art namens *Ch. morifolium*,
und zwar bei den Blüten in ein und demselben Köpfchen sind deren
Antipoden entweder in einer Reihe geordnet, oder durch die beiden
oberen Zellen und die untersten, welche gewöhnlich etwas lang und
dick sind, T-förmig. Wenn man dennoch von einem charakteristischen
Merkmal dieser Gattung sprechen soll, so würde es gerade darin be-
stehen, dass die Zahl, Anordnung und Konstruktion der Antipoden
stets inkonstant schwanken.

Die ungewöhnliche Kernvermehrung kann schon beim jungen
Embryosack, dessen Polkerne noch nicht verschmolzen sind, beobachtet
werden. Bei *Ch. morifolium* var. *genuinum* f. *japonense* z.B. waren
schon im obenerwähnten Stadium 6 Kerne der Antipoden vorhanden,

wiederum bei *Ch. parthenium* wurden 10 Kerne in der Antipoden-region des Embryosackes in demselben Stadium wahrgenommen (Text-fig. 7, 8 u. Taf. XXX, Fig. 1).

Bei *Ch. leucanthemum* sieht man sehr häufig Embryosäcke mit zwei Antipoden, deren Zellen fast immer mehrkernig sind oder Kerne von unregelmässiger Form enthalten. Die Spitze der untersten Anti-pode ist gewöhnlich angeschwollen, wohl aus dem Grunde, dass sie haustoriale Funktion besitzt (Textfig. 10). Auch bei *Ch. lavandulae-folium* beobachtet man Antipoden, welche aus zwei Zellen mit Kernen von unregelmässiger Gestalt bestehen. Unter den Arten dieser Gattung, die dem Verfasser zur Verfügung gestanden, scheint *Ch. parthenium* die zahlreichsten Antipoden haben zu können. Die Anzahl der Anti-poden beträgt 3–11, in den meisten Fällen sind diese in einer Reihe geordnet oder liegen unregelmässig umher. Für eine und dieselbe Spezies kann der Embryosack als recht variabel gelten. Bei *Ch. de-caisneanum* var. *radiatum* f. *satsumense* sind die Antipoden meist drei und T-förmig, seltener aber solche, deren unterste Zelle ausseror-dentlich gross entwickelt ist und zahlreiche Kerne zerstreut in sich schliesst (Taf. XXX, Fig. 5), wie es DAHLGREN (1920) bei *Bidens* beobachtet hat.

Der Verfasser hat das überall in Japan gezüchtete *Chrysanthemum*, nämlich *Ch. morifolium* var. *sinense* und als dessen originale Spezies geltendes *Ch. morifolium* var. *genuinum* f. *japonense* vergleichend untersucht. Beim ersten ist trotz der beträchtlichen Veränderungen der äusseren Form, vor allem aber der Kronblätter kein wesentlicher Unterschied im Bau des Embryosackes zwischen dessen verschiedenen Varietäten und der originalen Spezies zu bemerken, soweit es der Ver-fasser beobachtet hat. Nur ist die Variation innerhalb dieser Spezies ziemlich bedeutend, so z.B. bilden bei *Ch. morifolium* var. *genuinum* f. *japonense* zahlreiche Antipoden eine Reihe, oder sie sind nur 3 und T-förmig. Unter den Gartenvarietäten gibt es eine Gruppe namens ''Oogiku''—*Chrysanthemum* mit grossen Blüten—, bei welcher sowohl die Blüte als auch der Stengel gross wachsen. Sie hat bedeutend grosse Fruchtknoten und folglich breite Embryosäcke, sodass deren Antipoden meist T-förmig sind, während die Gruppe mit Namen ''Kogiku''—*Chrysanthemum* mit kleinen Blüten—in vielen Fällen in einer Reihe geordnete Antipoden zeigt, weil der Embryosack lang und schmal ist. Im alten Embryosack sieht man ebenso gewöhnlich Ver-mehrung und Verschmelzung der Kerne, wie bei anderen verwandten Arten.

# Ueber die Verdoppelung des Embryosackes

Im Nuzellus der Angiospermen befinden sich bekanntlich oft noch überflüssige Embryosäcke, wie sie z.B. CHAMBERLAIN (1895) bei *Aster Novae Angliae*, PALM (1915) bei *Emilia sagittata*, ISHIKAWA (1918) bei einigen Arten von *Oenothera* beobachtet haben. In den bisher bekannten Fällen ist diese Erscheinung derart erklärt worden, dass mehr als 2 unter den 4 Megasporen gleichzeitig zum Embryosack heranreifen. Auch bei *Chrysanthemum*-Arten kann man oft die Verdoppelung des Embryosackes zu Gesicht bekommen. Selten aber zeigen diese Embryosäcke gleichmässig eine vollkommene Entwicklung (Taf. XXXI, Fig. 7), meistens steht der eine am chalazalen Ende hinter dem anderen zurück oder hört unterwegs zu wachsen auf (Taf. XXXI, Fig. 6). In diesem Falle gerät man leicht in Gefahr, den überflüssigen Embryosack mit einer Antipode zu verwechseln; wenn man aber genauer ansieht, so zeigt es sich, dass die Kerne desselben von ganz normaler Form sind und weder verschmolzen noch degeneriert aussehen, was uns einen Anhaltpunkt zum Unterscheiden bietet. Es kommt auch hin und wieder vor, dass der Nebenembryosack noch in unreifem Zustand verbleibt, während der Hauptembryosack schon längst die Befruchtung durchgemacht hat und nun in Endospermbildung begriffen ist.

Hier sei noch kurz über die Ursache der Verdoppelung des Embryosackes von *Chrysanthemum* bemerkt. Wie oben erwähnt, haben die meisten dieser Arten über 2 Embryosackmutterzellen im Nuzellus, welche fast zu gleicher Zeit zu Tetraden sich entwickeln, um dann ihr Wachstum weiter fortzusetzen. Man darf also wohl annehmen, die Doppelembryosäcke würden nicht von den 2 Tetradenzellen, die sich von einer und derselben Embryosackmutterzelle entwickelt haben, sondern je von zwei besonderen Embryosackmutterzellen abstammen. Es ist bemerkenswert, dass nicht wenige Pflanzen mit zahlreichen Embryosackmutterzellen in ihrem einen Nuzellus zu denjenigen gehören, bei welchen schon die Verdoppelung des Embryosackes beobachtet worden sind.

## Zusammenfassung

1. Der Verfasser hat an *Chrysanthemum*-Arten embryologische Studien angestellt. Zur Ergänzung der Beobachtungen Prof. TAHARA's

wurde festgestellt, dass es oft Fälle gibt, wo bei vielen Arten über 2 Embryosäcke in ein und demselben Nuzellus vorhanden sind.

2. Die Tetraden, welche sich zum Embryosacke entwickeln, sind meistens solche am chalazalen Ende, sonst aber solche am mikropylaren Ende oder die zwei übrigen Makrosporen.

3. Die Antipodenzellen sind in bezug auf ihre Anzahl, Anordnung, Zustände der Kerne sehr häufig anomal. Die Kernvermehrung ist schon beim jungen Embryosack zu beobachten. Auch in einer bestimmten Spezies zeigt die Struktur der Antipoden eine bunte Mannigfaltigkeit.

4. Kein wesentlicher Unterschied in Bau des Embryosackes macht sich zwischen vielen Gartenvarietäten und deren originalen Spezies bemerkbar.

5. Bei Pflanzen dieser Gattung beobachtet man vielfach die Verdoppelung des Embryosackes, was mit der Tatsache, dass in vielen Fällen zahlreiche Embryosäcke in einem jeden Nuzellus der Pflanzen dieser Gattung sich befinden, in irgend eine Beziehung gezogen werden dürfte.

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# Tafelerklärung

## Tafel XXX

Fig. 1. *Ch. morifolium* var. *genuinum* f. *japonense.*   Junger Embryosack mit 5
          Antipodenkernen (vergr. 600).

Fig. 2. *Ch. indicum* var. *hibernum.*   Dritte Teilung des jungen Embryosackes
          (vergr. 430).

Fig. 3. *Ch. morifolium* var. *sinense* ("Kogiku," mit kleinen Blüten).   Die Anti-
          poden sind in einer Längsreihe geordnet (vergr. 430).

Fig. 4. *Ch. coronarium.*   Befruchtungsreifer Embryosack mit 2 Antipoden
          (vergr. 430).

Fig. 5. *Ch. decaisneanum* var. *radiatum* f. *satsumense.*   Die untereste Zelle
          weist viele zerstreute Kerne auf (vergr. 430).

## Tafel XXXI

Fig. 6. *Ch. decaisneanum* var. *radiatum* f. *satsumense.*   Doppelembryosack,
          Nebensack im unreifen Zustand (vergr. 430).

Fig. 7. Derselbe im fast vollendeten Wachstum.

Fig. 8. *Ch. morifolium* var. *sinense* ("Oogiku," mit grossen Blüten).   Der Sack
          mit sehr weiter Breite, jeder Antipoden degeneriert (vergr. 430).

Fig. 9 u. 10. *Ch. morifolium* var. *genuinum* f. *japonense.*   Ältere Embryosäcke
          mit degenerierenden Antipodenkernen (vergr. 430).

1   2   3   4   5

7

6

8

9

10
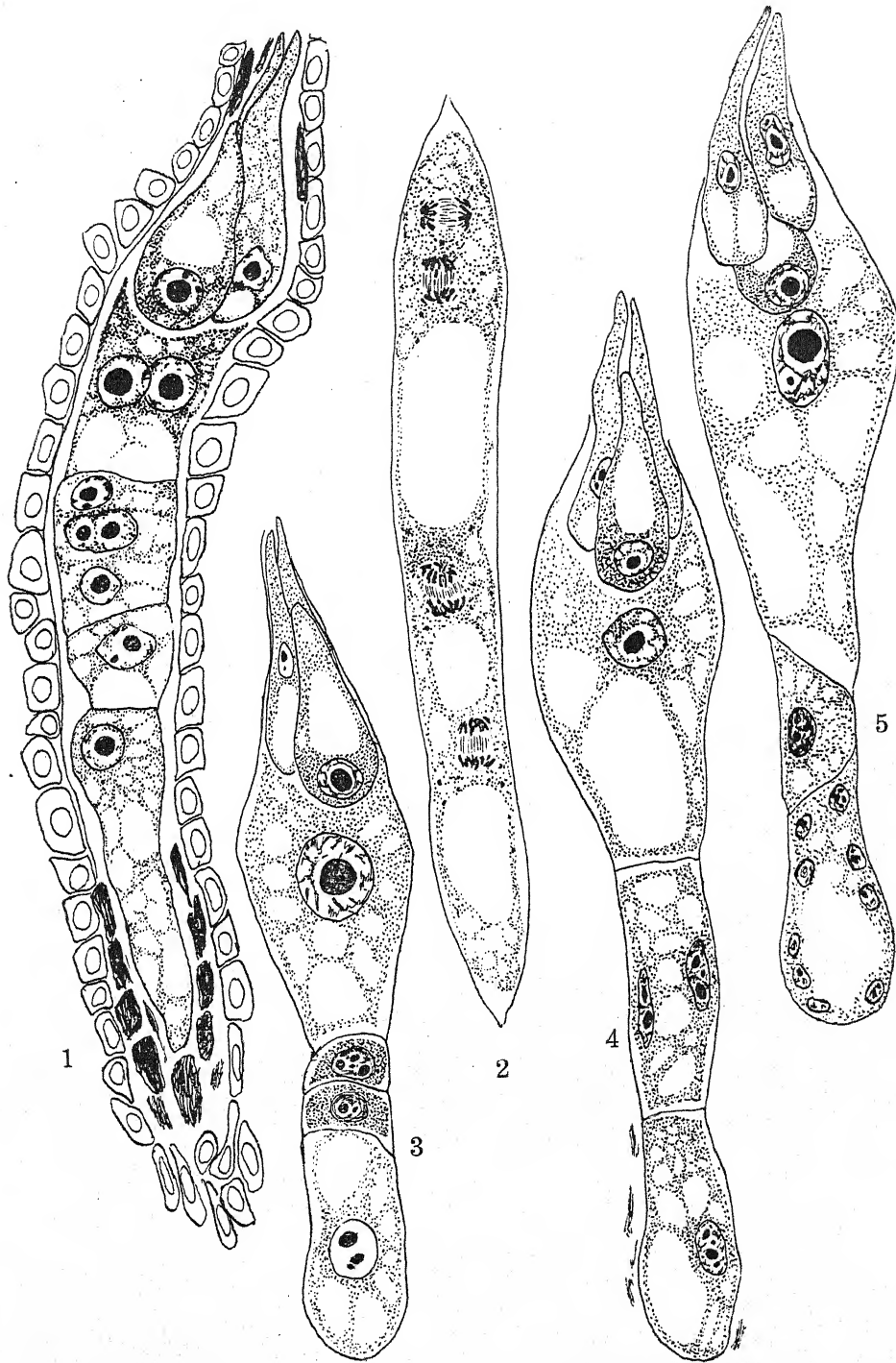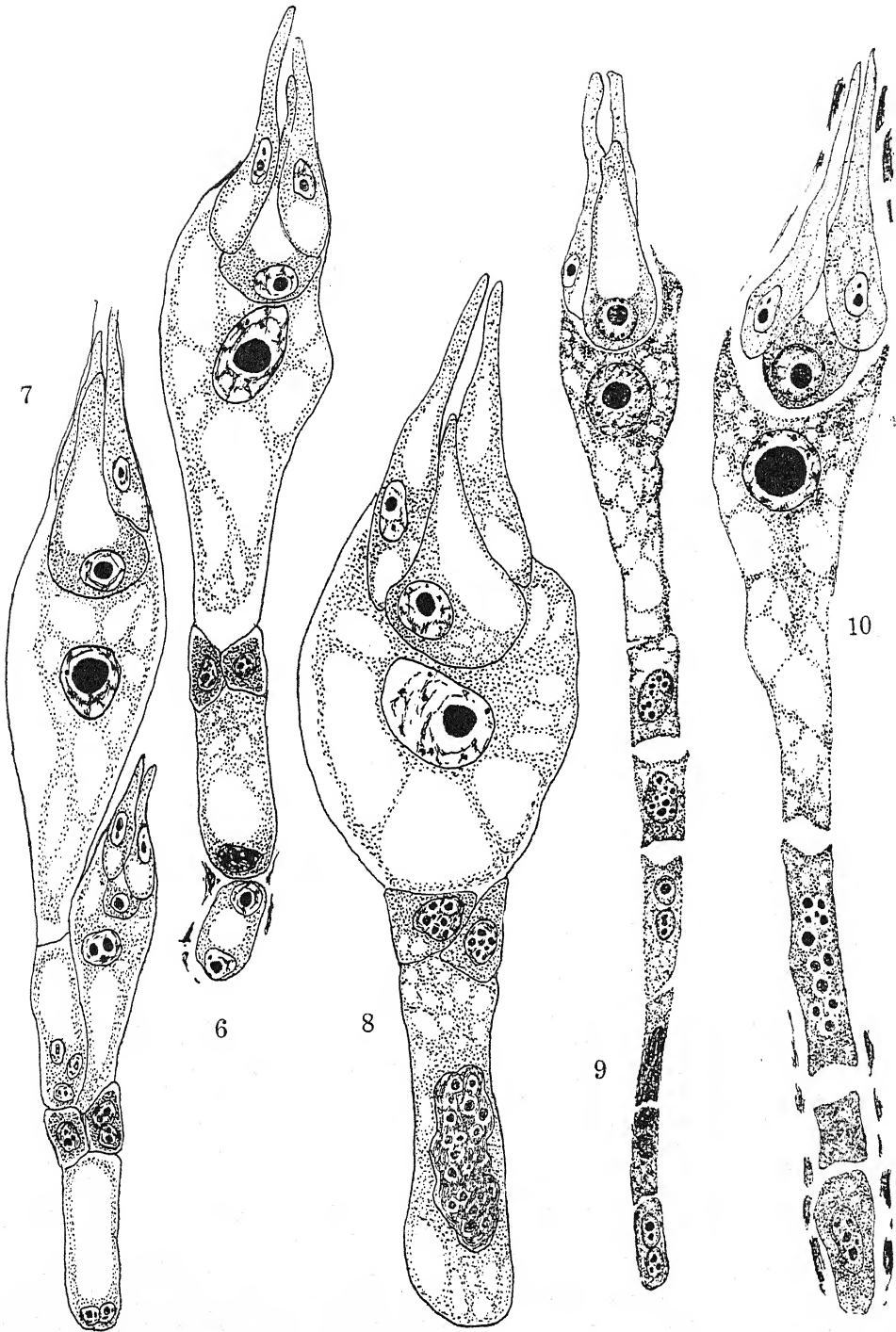
# *Chœnomeles* in Japan

By Takenoshin NAKAI

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The cultivation of *Chœnomeles* in Europe began in the latter part of the eighteenth century. In the latter half of the last century, European horticulturists started the hybridation of *Chœnomeles*, and produced a number of new hybrids, which are distributed all over Europe, so that at present one can hardly discriminate the garden forms from their progenitors. Japan had no garden hybrids; she is the only country where we can see the real species of *Chœnomeles*. Recently, Japanese horticulturists began to import European hybrids. These new hybrids are more decorative than the old races, and they are gradually taking the place of the old, so that it will not be long before we shall face the same difficulty of discrimination as in Europe.

Japan has only one indigenous *Chœnomeles*, *C. Maulei*. The garden plants with showy flowers were introduced from China, principally for medicinal purposes, but now the date of their introduction is unknown.

Engelbert KAEMPFER was the first European to describe *Chœnomeles*. In page 844 of his *Amœnitatum Exoticarum* fasc. V (1712), he described as "木瓜 Buke, Arbuscula Acaciæ Germanicæ facie, flore pentapetalo rubro." This is our garden *Chœnomeles*, commonly known as *Cydonia japonica* or *Chœnomeles japonica*. The name is *Boke* (not *Buke*) which was derived from either the Japanese or Korean pronunciation of the Chinese characters 木瓜. In Japanese, it is read as *Boke*, and in Korean *Muge*. THUNBERG thought this *Buke* of KAEMPFER identical with the Japanese *Chœnomeles* which he found at Mt. Hakone (Fakone by him) of the province Sagami. He has given a botanical name *Pyrus japonica* to it, and described it in *Nova Acta Regiæ Societatis Scientiarum Upsaliensis*, Vol. III., p. 208 (1780) as "foliis cuneatis, crenatis, glabris: floribus solitariis." This description is short, but well brings out the characteristics of his type specimens kept at Upsala University. The type consists of two flowering specimens mounted on a single sheet. It is no other than the *Chœnomeles* known under the names of *Chœnomeles alpina* or *Cydonia Maulei*. It is a small shrub

not taller than three feet (in wild state), frequent in dry grassy hills or plains, or at the foot of mountains in the main-island and Kiusiu. It likes clayey soil and propagates rapidly by its rhizome. It fruits well, but the seeds are scanty, for they are largely eaten by insects. It is planted rarely in the gardens, but within a few years, it becomes quite annoying as its rhizomes run through the walls and stone fences.

The Japanese garden *Chœnomeles* consists of five distinct species. These are distinguished as follows.

1 {
    Rhizoma subterraneum longe repens, exquo innovationes surgunt.
        Frutex nanus vulgo 0.3–1 metralis. Planta glaberrima.
        Folia vulgo obovata cuneata. Fructus rotundatus. ............*C. Maulei.*
    Rhizoma breve ita caules cæspitosi. Frutex elatior usque 2–4 metralis. .......2
}

2 {
    Columna styli floccoso-tomentosa. Calycis lobi intus villosi.
        Folia oblanceolata vel late oblanceolata. .................*C. extus-coccinea.*
    Columna styli glaberrima vel pilosella. Calycis lobi intus pilosi. ............3
}

3 {
    Folia lanceolata vel anguste lanceolata, ab initio glaberrima.
        Flores candidi, diametro 2–3 cm. Stylus glaberrimus. Ovarium obovatum.
                .............*C. eburnea.*
    Folia late oblanceolata vel elliptico-oblanceolata vel obovato-oblonga. Ovarium
        oblongum. .........................................................4
}

4 {
    Rami et folia pilosa sed glabrescentia. Flores diametro 3–4 cm.....*C. speciosa.*
    Rami et folia ab initio glaberrima. Flores diametro 5–6 cm. .....*C. cardinalis.*
}

## Enumeration of Species

**1. *Chœnomeles Maulei* Lavallée apud Beissner, Schelle & Zabel, Handb. Laubholzbenen. 182 (1903)—Schneider, Illus. Handb. Laubholzk. I. 731, fig. 405, g-s, 406, c-d. (1906).**

Syn. *Shidomi, Kusaboke,* Kaibara, Yamato Honzo XII., fol. 20 (1708).

*Pyrus japonica* Thunberg in Nova Acta Reg. Soc. Sci. Upsal. III. 208 (1780); Fl. Jap. 207 (1784), excl. syn.—Murray, Syst. Veg. ed 14., 467 (1784)—Vitman, Summa Pl. III. p. 232 (1789)—Persoon, Syst. Veg. etc. 15, 501 (1797)—Willdenow, Sp. Pl. II, 1020 (1803)—Koch in Ann. Mus. Bot. Lugd. Bat. I, 248 (1864)—Miquel in Ann. Mus. Bot. Lugd. Bat. III, 40 (1867), quoad plantam ex Hakone; Prol. Fl. Jap. 228 (1867), quoad plantam ex Hakone—Franchet & Savatier, Enum. Pl. Jap. I, 138, incl. *β alpina* (1875).

*Cydonia japonica* Persoon, Syn. Pl. II, 40 (1807), pro parte—A. P. de Candolle, Prodr. II, 638 (1825), pro parte.

*Sashi, Shitomi, Kusaboke Noboke,* IWASAKI, Honzo Dzufu LX, fol. 9. sin. (1828).

*Chœnomeles japonica β. alpina, γ. pygmœa* MAXIMOWICZ in Bull. Acad. Sci. St. Pétersb. XIX, 168 (1873); in Mél. Biol. IX, 163 (1873) —DECAISNE, Mém. Pom. 130 (1874).

*Pyrus Maulei* MASTERS in Gard. Chron. n. ser. I, 756, fig. 159 (1874); II, 740, fig. 144 (1874)—J. D. HOOKER in Bot. Mag. CX, t. 6780 (1884).

*Pyrus japonica* var. *pygmœa* TANAKA & ONO, Useful Pl. Jap. II, Pl. 633 (1891).

*Cydonia Maulei* MOORE in Flor. & Pomol. 1875, 49 cum. tab.— NICHOLSON, Dict. Gard. I, 419 (1887)—NICHOLSON & MOTTET, Dict. Prat. II, 110, fig. 171 & 172, (1885).—FRAHM in Gartenwelt, II, 214 (1898)—OLBRICH in Gartenwelt, IV, 270 (1900)—BEAN, Trees & Shrubs Brit. I, 453 (1914).

*Chœnomeles japonica* var. *Maulei* LAVALLÉE, Arb. Segrez. 110 (1877); nom.

*Pseudochœnomeles Maulei* CARRIÈRE in Rev. Hort. LIV, 236, fig. 52-55 (1882).

*Chœnomeles alpina* KOEHNE, Gatt. Pom. 28, t. 2, fig. 23, a-c (1890) —DIPPEL, Handb. Laubholzk. III, 408 (1893).

*Cydonia Sargentii* LEMOINE, Cat. 142, 25 (1900).

*Cydonia Maulei* var. *alpina* REHDER in BAILEY, Cyclop. Americ. Hort. I, 427 (1900).

*Chœnomeles Maulei* var. alpina SCHNEIDER, l. c.

*Chœnomeles japonica* (non LINDLEY) KOIDZUMI in Journ. Coll. Sci. Tokyo XXXIV, art. 2, 95 (Consp. Rosac. Jap.) (1913), pro parte— REHDER in SARGENT, Pl. Wils. II, 298 (1915).

Patria: Hondo & Kiusiu.

*Chœnomeles Maulei* var. **alba** NAKAI, var. nov.

Syn. *Hakurin Kaido* IWASAKI, Honzo Dzufu LX, fol. 10, dextr. (1828).

Flores candidi.

Probably this variety has been found in wild state and cultivated in gardens. I have not yet seen this either wild or cultivated.

*Chœnomeles Maulei* var. **tortuosa** NAKAI, var. nov.

Caulis, rami et aculei varie tortuosi.

In hortis Japonicis rara.

2. **Chænomeles extus-coccinea** CARRIÈRE in Rev. Hort. XLIV, in tab. fig. 3 (1872).

Syn. *Kara-boke* KAIBARA, Yamato Honzo XII, fol. 20 (1708).
*Cydonia japonica albo-cincta* V. HOUTTE in Flore des Serres IV, 2e sér. 23 & 24 (1861).
*Chænomeles japonica* var. *fl. roseo, albo-cincta* V. HOUTTE, l. c.
*Cydonia japonica rosalba* V. HOUTTE, l. c. t. 1403.
*Chænomeles japonica extus coccinea* CARRIÈRE l. c. 331 (1872).
*Chænomeles lagenaria* KOIDZUMI in Tokyo Bot. Mag. XXIII, 173 (1909), excl. syn.; in Journ. Coll. Sci. Tokyo XXXIV, art. 2, 94 (Consp. Rosac. Jap.) (1913), excl. syn.

Patria: China.

This is one of the oldest garden plants in Japan. The most distinguished characteristics of this species is the woolly column of styles. Formerly, the fruits of this species were used for medicinal purposes, so this was abundantly cultivated in the medical garden of the Tokugawa Government (the present Koishikawa Botanic Garden of Tokyo Imperial University). Comparing with the red-flowered *Chænomeles speciosa* which has been much appreciated in the gardens, this species is less ornamental, yet was planted much on account of its fruits. Dr. KOIDZUMI made a new combination of *Chænomeles lagenaria* out of *Cydonia lagenaria* for this species, but *Cydonia lagenaria* of LOISELEUR-DESLONGCHAMPS is *Chænomeles speciosa* with a glabrous or pilose style and rosy red petals. The following varieties of European garden origin have inherited the characteristics of this species; they have the woolly styles.

*Cydonia marmorea* hort.

Flores ut *Chænomeles extus-coccinea*, sed majores.

*Cydonia Kermesiana semiplena* hort.
Flores lilacini maximi.

*Cydonia japonica cardinalis* SPAETH apud MUTH in Gartenwelt VII, p. 113 fig. 2. (1902), non Carrière.

Flores ignescenti-rubri mediocres.

*Cydonia japonica rosea plena* hort.
Flores mediocres, rosei, semipleni.

3. **Chænomeles eburnea** CARRIÈRE in Rev. Hort. XLIV, 331, & sub tab. fig. 4 (1872)—NAKAI in Tokyo Bot. Mag. XXXII, 146 (1918).

Syn.  *Shiroboke* KAIBARA, Yamato Honzo XII, fol. 20. (1708).

*Shirobana-boke* vel *Hakkwa-boke* IWASAKI, Honzo Dzufu LX, fol. 8, sin (1828).

*Cydonia japonica candida* V. HOUTTE in Flore des Serres 2 sér. IV. 24 (1861).

*Chœnomeles japonica* var. *nivalis* MOUILLEFERT, Traité Arb. & Arbris. I. 540 (1892–98)—BEISSNER, SCHELLE & ZABEL, Handb. Laub-holz-Benen. 181 (1903)—BEAN, Trees & Shrubs Brit. I. 452 (1914).

*Chœnomeles japonica* var. *eburnea* MOUILLEFERT, l. c.

*Chœnomeles angustifolia* KOIDZUMI in Journ. Coll. Sci. Tokyo XXIV, art. 2, 97 (Consp. Rosac. Jap.) (1913).

*Chœnomeles angustifolia* var. *eburnea* NAKAI in Tokyo Bot. Mag. XXXVII, 69 (1923).

Patria:  China.

This is a narrow-leaved *Chœnomeles*.  The ovary of the female flower is obovate.  The leaves, branches, and styles of female flowers are always glabrous.

### 4.  *Chœnomeles speciosa* NAKAI, comb. nov.

Syn.  *Yodo-boke, Choshun-boke* KAIBARA, Yamato-Honzo XII, fol. 20 (1708).

*Buke* KAEMPFER, Amœnit. Exot. p. 844 (1712).

*Pyrus japonica* (non THUNBERG) JACQUIN, Frag. Bot. 85, t. 136, fig. 3 (1809)—MIQUEL in Ann. Mus. Bot. Lugd. Bat. III, 40; Prol. Fl. Jap. 228 (1867), quoad pl. cult.—KURZ in Journ. Bot. XI, 193 (1873)—HEMSLEY in Journ. Linn. Soc. XXIII, 257 (1887).—TANAKA & ONO, Useful Pl. Jap. II, Pl. 632 (1891).

*Malus japonica* ANDREWS, Bot. Reposit. VII, t. 462 (1806).

*Cydonia japonica* PERSOON, Syn. Pl. II, 40 (1807), pro parte—LOISE-LEUR DESLONGCHAMP. Herb. Amat. II, t. 73 (1817)—A. P. DE CAN-DOLLE, Prodr. II, 638 (1825), pro parte—G. DON, Gen. Hist. II, 650 (1832), pro parte—SIEBOLD & ZUCCARINI in Abh. Akad. Muench. IV, abt. II 131 (1845)—WENZIG in Linnaea XXXVIII, 10 (1874)—LAUCHE, Dentsch. Dendrol. 601 (1883)—NICHOLSON & MOTTET, Dict. Prat. II. 109, (1885)—NICHOLSON, Dict. I, 419, t. 587 (1887)—PALIBIN in Acta Hort. Petrop. XVII, 74 (Consp. Fl. Kor. I.) (1898)—NAKAI in Journ. Coll. Sci. Tokyo XXVI, art. 1, 182 (Fl. Kor. I.) (1909)—BEAN, Trees & Shrubs Brit. I, 452 (1914).

*Cydonia lagenaria* LOISELEUR DESLONGCHAMPS in Nouv. Duhamel
IV, 255, t. 76 (1813 ?)

*Cydonia speciosa* SWEET, Hort. Suburb. Lond. 113 (1818); nom. nud.

*Cydonia speciosa a. rubriflora* GUIMPEL, OTTO & HAYNE, Abbild.
frem. Holzg. 88 t. 70 (1825).

*Cydonia japonica a. rubra* SWEET, Hort. Brit. 136 (1827).

*Hiboke* IWASAKI, Honzo Dzufu LX, fol. 9, dextr. (1828).

*Chœnomeles japonica* LINDLEY apud BUNGE in Mém. Sav. Etr.
Acad. Sci. St. Pétersb. II, 101. n. 163 (Enum. Pl. Chin. bor.) (1835)
—SPACH, Hist. Veg. II, 159 (1834).—DECAISNE in Nouv. Arch. Mus.
Paris X, 129 (1874), pro parte—KOEHNE, Gatt. Pomac. 28 (1890)
—MOUILLEFERT, Traité Arb. & Arbris. I, 540 (1892-8)—DIPPEL,
Handb. III, 407 (1893)—DIELS in ENGLER, Bot. Jahrb. XXIX, 388
(Fl. Centr. China) (1900).—BEISSNER, SCHELLE & ZABEL, Handb.
Laubholz-Benen. 181 (1903)—SCHNEIDER, Illus. Handb. I, 730, fig.
405 h-o', 406 b (1906)—KOIDZUMI in Journ. Coll. Sci. Tokyo XX-
XIV, art. 2, 95 (Consp. Rosac. Jap.) (1913), pro parte.

*Chœnomeles japonica* LINDLEY var. *a.* genuina MAXIMOWICZ in
Bull. Acad. Imp. St. Pétersb. XIX, 168 (1873); in Mél. Biol. IX,
163 (1873)—FRANCHET in Nouv. Arch. Mus. Paris sér. 2. V, 271 (Pl.
David. I, 119) (1883).

*Pyrus spectabilis* (non AITON) FRANCHET & SAVATIER, Enum Pl.
Jap. I, 138 (1875); quoad specimen e Yokoska no 402.

*Cydonia japonica* var. *genuina* ITO in Tokyo Bot. Mag. XIV. 117
(1900).

*Cydonia japonica* var. *lagenaria* MAKINO in Tokyo Bot. Mag. XXII,
64 (1908), pro parte.

*Chœnomeles lagenaria* REHDER in SARGENT, Pl. Wils. II, 296 (1915),
non Koidzumi.

*Chœnomeles trichogyna* NAKAI in Tokyo Bot. Mag. XXX, 23 (1916);
Fl. Sylv. Kor. VI, 42. t. XV (1916); in Tokyo Bot. Mag. XXXVII,
70 (1923); in nota sub C. angustifolia.

*Chœnomeles cardinalis* NAKAI in Tokyo Bot. Mag. XXXII, 145
(1918), non CARRIÈRE.

Patria: China.

The following specimens in the general herbarium of Muséum
d'Histoire naturelle de Paris belong to this species.

China: Tibet orient; Ta-Tsien-Lou (J. A. SOULIÉ no. 701); Tsekou &
Nekou (J. A. SOULIÉ no. 1656); Schensi merid. (David.); Su-tchuan;

Tchen-Kéou-Tin (FARGES no. 1446); Yunnan; Hay-tien (F. DU-
CLOUX no. 2458); Lao-Kouy-Chan (F. DUCLOUX no. 5682); pede
montis Tong-Tchousu 2500 m. (E. E. MAIRE, partim.)

Korea: Tun Kwan Tai Kul, ubi culta, (Sontag).

Japonica: Akita, ubi culta, (U. FAURIE no. 2200); Fukuyama, ubi
culta, (FAURIE no. 3786); Aomori, ubi culta, (FAURIE no. 147).

I must correct my note on this species published in the *Tokyo
Botanical Magazine*, Vol. XXXII, p. 70. This species is not indigenous
in Liukiu, but was introduced there either directly from China or in-
directly from Japan. Mr. T. IWASAKI has erroneously informed me by
a letter in which he wrote that he found this species abundantly grow-
ing in the Ishigaki Island of the Yaeyama Archipelago. And he was
so sure that there was no doubt of its wild growth in that island. Dr.
G. KOIDZUMI, who went there later, told me that Mr. IWASAKI is a
venerable patriarch of the island. He never collects the plants him-
self, but makes the inhabitants do the work for him. In the case of
*Chænomeles*, one who collected the specimens has given him the false
information, and this very information caused my error.

This species is much used in Japan for ornamental purposes. The
oldest stems attain two or three meters in height. The hairs of style
are scanty, often not found.

**5. *Chænomeles cardinalis* CARRIÈRE** in Rev. Hort. LXIV, sub
tab. fig. 1 (1872).

Syn.   ? *Pyrus japonica* (non THUNBERG) SIMS in Bot. Mag. XVIII, t.
692 (1803).

*Hiboke* ONO, Honzo Komoku Keimo XXVI, fol 5 (1803).
*Chænomeles japonica* var *cardinalis* CARRIÈRE, l. c. p. 334 (1872).

Patria:   China.

This is most closely related to *Chænomeles speciosa*, but the leaves
and branches are perfectly glabrous from the beginning; the leaves
are broader; and the flowers are larger. The following garden varie-
ties seem to have varied from this directly.

*Chnæomeles cardinalis* var. **alba** NAKAI, comb. nov.

Syn.   *Kaido-boke* ONO, Honzo Komoku Keimo XXVI, fol. 5 (1803).

*Pyrus japonica alba* LODDIGES, Bot. Cab. VI, no. 541 (1821).
*Chænomeles japonica Mallardii* CARRIÈRE in Rev. Hort. XLIV,
331 (1872).

*Chænomeles Mallardii* CARRIÈRE, l. c. sub tab. fig. 2.

*Cydonia japonica* var. *alba* REHDER in BAILEY, Cyclop. 427 (1900).

*Chænomeles japonica* var. *alba* REHDER in BAILEY, Stand. Cyclop. 728 (1914).

*Chænomeles eugenioides* KOIDZUMI in Tokyo Bot. Mag. XXIX, 160 (1915).

*Chænomeles eugenioides* var. *alba* NAKAI in Tokyo Bot. Mag. XXXVII, 72 (1923).

Petala albida rubro-suffusa.

*Chænomeles cardinalis* var. **tortuosa** NAKAI, comb. nov.

Syn.   *Chænomeles eugenioides* var. *tortuosa* NAKAI in Tokyo Bot. Mag. XXXVII, 72 (1923).

Rami et aculei irregulariter tortuosi. Folia et flores ut antea, sed petala falcato-involuta.

In hortis culta.

# Über die wildwachsenden gefülltblütigen Stöcke von *Gardenia jasminoides,* Ellis

Von Toichi ASAI

Die Zierpflanzen zeigen in der Grösse, Farbe und Form ihrer Blüten meistens den auffallenden Gegensatz zu den wildwachsenden Pflanzen selber Art, wenn im allgemeinen die Geschichte, von welcher wildwachsenden Stammpflanze sie entsprungen sind, unbekannt bleibt. Die gefüllte Blüte, welche entweder durch die blütenblattartige Metamorphose der Kelch-, ·Staub- und Fruchtblätter oder durch die Zerteilung und Verdoppelung der Kronenblätter selbst entstanden ist, ist ein häufiges Merkmal der Zierpflanze. Die Erblichkeit dieser abnormen Eigenschaft ist des öfteren nachgewiesen worden.

In der Natur begegnet man selten den Pflanzen mit gefüllten Blüten, wie z. B. *Ranunculus acris, Narcissus Tazzeta* usw.[1] Unter unseren durch die Gärtner als Zierpflanze angepflanzten Holzgewächsen gibt es viele Varietäten mit gefüllten Blüten, wie z.B. bei *Prunus, Thea, Rhododendron, Punica, Nerium* und *Gardenia,* wenn die Geschichte ihrer Entstehung völlig unbekannt ist. Betreffend die gefüllte Blüten tragenden wildwachsenden *Rhododendron*-Arten, haben wir einige Mitteilungen, nämlich bezüglich *R. brachycarpum* auf Azumayama in der Provinz Iwashiro[2] und *R. chrysanthum* auf Yatsugatake in der Provinz Shinano,[3] wozu ich hinzufügen möchte, dass die gleichartigen *Rhododendron*-Arten schon früher sowohl in Europa[4] als in Nordamerika[5] bekannt geworden sind. Bei den japanischen *Rhodo-*

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(1) Ich habe gehört, dass wildwachsende *Narcissus Tazzeta* mit gefüllten Blüten auf der in der Mitte der Ariyakebucht liegenden kleinen Insel Yushima weit verbreitet vorkommt.

(2) M. MIYOSHI, Über das Vorkommen gefüllter Blüten bei einem wildwachsenden japanischen *Rhododendron*, nebst Angabe über die Variabilität von *Menziesia multiflora*, MAXIM. (Jour. Coll. Sci. Imp. Univ. Tokyo, **27**, Art. 11. 1910).

(3) Y. YABE, On double-flowering yellow *Rhododendron (Rhododendron chrysanthum*, PALL. forma *senanense*, YABE). (Bot. Mag. Tokyo, **41**, S. 271, 1927).

(4) A. KERNER, Oesterr. Botan. Zeits. **15**, 285, 1865.

(5) A. REHDER, Bot. Gaz. **43**, No. 4. S. 261, 1907.

*dendron*-Arten sind nicht bloss die gutentwickelten gefüllten Blüten an jedem doldigen Blütenstand vorhanden, sondern auch meistens noch einige ganz normale dazu gemengt gefunden.

Ich habe die gefüllten Blüten an den wildwachsenden Stöcken von *Gardenia jasminoides*, ELLIS auf dem Hügel Tatsuda in Kumamoto gefunden. Alle von mir untersuchten Stöcke sind durch die Produktion von gefüllten Blüten ausgezeichnet. Darunter tragen einige merkwürdigerweise ausser den gewöhnlichen gefüllten noch dieselben in verschiedenem Füllungsgrade an einem und demselben Stock, die die Übergänge von der gewöhnlichen gefüllten Stammform zu der komplizierten Form darstellen.

## *Gardenia jasminoides*, ELLIS und ihre Verbreitungsbezirke in Japan

*Gardenia jasminoides*, ELLIS (*G. florida*, L. nach gewissen Autoren) ist bei uns eine beliebte Zierpflanze, wegen ihrer schneeweissen Blüten mit einem süssen Aroma; sowohl sie als auch *Gardenia radicans*, THUNB. werden bei uns überall in dem Garten angepflanzt. Der erste, welcher ein immergrüner Strauch ist, wächst bis zu etwa 2–3 m Höhe; eine fünfzigjährige *Gardenia*-Pflanze, welche ich einst in Kumamoto gesehen habe war 4 m in der Höhe und 52 cm am Stammumfang bei 15 cm über dem Boden. Am Zweige werden die langeiförmigen ganzrandigen Laubblätter dekussiert gestellt. Die miteinander verwachsenen Nebenblätter bilden eine zylindrische Scheide. Die radiäre Blüte ist tetrazyklisch und jedes Zyklus ist sechsgliederig. Das Kronenrohr ist fleischig; die Krone ist tief sechsspaltig und bei der Knospe linksgedreht. Die Staubblätter mit kurzen Filamenten sind an dem Mund der Blütenkrone inseriert und jedes alterniert mit den Kronenlappen. Die Pollenkörner sind tetraedrisch. Der Fruchtknoten ist einfächerig mit zahlreichen Samenanlagen. *Gardenia jasminoides* liefert die als Färbemittel wohl bekannten Gelbschoten mit sechs Rückenlippen.

*Gardenia jasminoides*, ELLIS, eine in Ostasien einheimische Rubiacee, ist der von dem südlichen Teil der nördlichen gemässigten Zone aus bis zu den Subtropen gut gedeihende immergrüne Strauch. Hauptsächlich ist sie im südlichen Gebiete von Japan und China aufgefunden. In Japan ist sie im Norden bis nach Suoo, Bizen und Kii verbreitet und auch sogar bis nach Suruga und Idu eingedrungen. Auf Shikoku und

Kiusiu wächst *Gardenia jasminoides* fast überall und erstreckt sich südwärts bis zu Liukiu und Formosa. Wir mögen im Ganzen sagen, dass die nördliche Grenze von *Gardenia jasminoides* in Japan ungefähr bei 34° ½ nördl. Br. liegt.

## Die Vegetation auf dem Hügel Tatsuda

In der Nähe unserer Fünften Höheren Schule, Kumamoto liegt ein Hügel Tatsuda, welcher dem Marquis HOSOKAWA gehört. Er ist 151,6 m hoch; er erstreckt sich 1,9 km von West nach Ost und 1,1 km von Süd nach Nord. Er beträgt 5,8 km im Umkreis und etwa 2 qkm in der Fläche. Auf diesem Hügel, ausgenommen einen Teil an der nördlichen Seite, wo *Chamæcyparis obtusa* und *Cryptomeria japonica* beförstet sind, wachsen dicht die immergrünen *Pasania cuspidata* und *Pinus densiflora* und der Waldschatten ist ganz und gar mit verschiedenen Sträuchern und Farnen bedeckt. Die Pflanzen, welche von mir dort bemerkt worden sind, sind wie folgt:

*Diplazium lanceum*, PR.
*Drymoglossum microphyllum*, C. CHR.
*Gleichenia glauca*, HK.
*Gleichenia linearis*, CLARKE
*Pteridium aquilinum*, KUHN
*Woodwardia japonica*, SM.
*Lycopodium serratum*, TH. var. *javanicum*, MAK.
*Pinus densiflora*, SIEB. et ZUCC.
*Chloranthus glaber*, MAK.
*Myrica rubra*, SIEB. et ZUCC.
*Pasania cuspidata*, OERST.
*Quercus dentata*, THUNB.
*Quercus glandulifera*, BLUME
*Quercus glauca*, THUNB.
*Quercus myrsinæfolia*, BLUME
*Ficus erecta*, THUNB.
*Ficus erecta*, TH. var. *Sieboldi*, KING
*Schoepfia jasminodora*, SIEB. et ZUCC.
*Nandina domestica*, THUNB.
*Cinnamomum Camphora*, NEES. et EBERM.
*Cinnamomum pedunculatum*, NEES.
*Machilus Thunbergii*, SIEB. et ZUCC.
*Albizzia Julibrissin*, DURRAZ.
*Desmodium laburnifolium*, DC.

*Lespedeza bicolor*, TURCZ. var. *intermedia*, MAXIM.
*Milletia floribunda*, MATSUM.
*Milletia japonica*, A. GRAY.
*Pueraria hirsuta*, MATSUM.
*Mallotus japonicus*, MUELL. ARG.
*Rhus javanica*, L.
*Ilex Oldhami*, MIQ.
*Eurya japonica*, TH. var. *Thunbergii*, THW.
*Eurya ochnacea*, SZYSE.
*Taonabo japonica*, SZYSE.
*Thea japonica*, NOIS. var. *spontanea*, MAK.
*Elæagnus pungens*, THUNB.
*Gilibertia trifida*, MAK.
*Pirola japonica*, MAK.
*Vaccinium bracteatum*, THUNB.
*Ardisia crispa*, DC.
*Ardisia japonica*, BLUME
*Diospyros Kaki*, L. var. *sylvestris*, MAK.
*Styrax japonicus*, SIEB. et ZUCC.
*Ligustrum japonicum*, THUNB.
*Trachelospermum divaricatum*, K. SCHUM.
*Gardenia jasminoides*, ELLIS

*Lonicera japonica,* THUNB.
*Viburnum erosum,* THUNB.
*Arundinaria variabilis,* MAK. var. *Akebono,* MAK.
*Arundinella anomala,* STEUD.

*Lophatherum gracile,* BRONGN. var. *elatum,* HACK.
*Sasa albo-marginata,* MAK. et SHIBATA
*Smilax China,* L.
*Smilax herbacea,* L. var. *Oldhami,* MAXIM.

Die immergrünen Pflanzen, welche im südlichen Teil Japans im allgemeinen verbreitet sind, kommen auch hier vor, und die Gewächse, welche in dieser warmen Gegend eigentümlich sind, z.B. *Gleichenia, Woodwardia, Chloranthus, Myrica, Pasania, Schoepfia, Nandina, Cinnamomum, Machilus, Ilex, Eurya, Taonabo, Thea, Gilibertia, Ardisia, Diospyros, Ligustrum, Trachelospermum, Gardenia* sind fast ausnahmslos immergrün. *Pasania* und *Pinus,* welche die wichtigen Bestandteile des Waldes hier ausmachen, sind von sehr schlanker Statur: die Höhe solcher Bäume beträgt nämlich 15–20 m, während der Stammumkreis in der Brusthöhe nur 0,4–1 m misst. Unter dem Baumschatten wachsen hauptsächlich die Sträucher wie *Quercus glauca, Ilex Oldhami, Eurya japonica, Vaccinium bracteatum* und *Gardenia jasminoides* usw. ziemlich dicht. Da diese Schattenpflanzen zum grossen Teil Sträucher sind, entwickeln sie sich nicht sehr gross, da sie kaum über 2 m Höhe wachsen.

*Gardenia jasminoides,* welche eine von den auf diesem Hügel verbreiteten allergewöhnlichsten Schattenpflanzen ist, wird durchschnittlich 20–30 Stöcke pro Quadratzehnmeter gefunden; sie produziert schneeweisse Blüten im regnerischen Juni und trägt die Gelbschoten im Herbst.

## Das Vorkommen von gefülltblühenden *Gardenia jasminoides* auf dem Hügel Tatsuda

Als am 8. Juli 1920 die Laubblätter von *Gardenia jasminoides* auf Tatsuda für meine biochemische Arbeit gesammelt wurden, wurde ich zufällig auf eine gefüllte Blüte derselben Pflanze aufmerksam gemacht. Ich habe mir die Mühe gegeben, um bei der Blütezeit von *Gardenia* im nächsten Jahre die Gegend wieder aufzusuchen, aber leider habe ich damals keine gefüllten Blüten finden können. Es war am Beginn Juli 1922, wo die Blütezeit dieser Pflanze schon fast vorüber ist und nur selten noch einige Blüten hie und da gesehen werden können, als mein Assistent K. YASUKAWA einen Stock mit den gefüllten Blüten auffand. Seine Fundstelle ist beinahe 400 m

nach Nordost von dort aus entfernt, wo ich früher den Stock mit den gleichartigen Blüten gefunden hatte. An dem von ihm gefundenen Stocke fanden sich nur zwei schlanke Zweige in der 1 m Höhe über dem abgeschnittenen Ende, und ausser zwei kompliziert-gefüllten Blüten wurden dabei weder die Blüten-knospen noch die Fall-spuren der Blüten vorge-funden. Dabei waren die Laubblätter etwas kleiner als bei der gewöhnlichen Form, doch waren es im Ganzen keine Besonder-heiten nachzuweisen (Fig. 1).

Bis zum Ende Juni nächsten Jahres haben wir einigemal den Hügel be-sucht und fanden am 30. Juni 1923 nach vielen Bemü-hungen wieder einen Stock mit gefüllten Blüten an der Stelle, wo ich zum
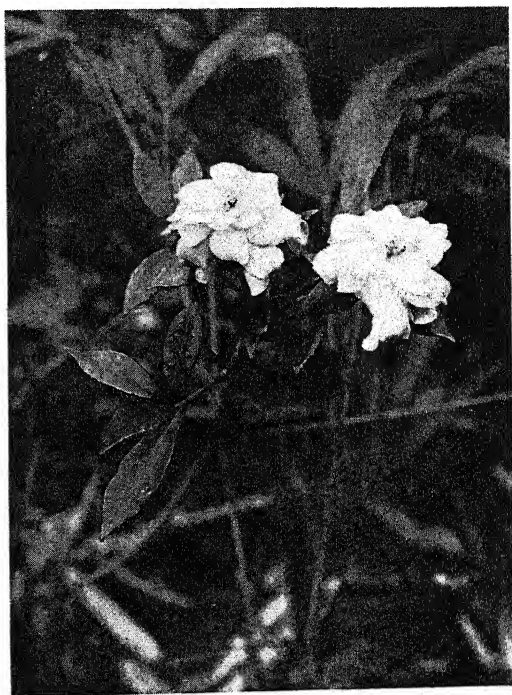


Fig. 1. *G. jasminoides* mit gefüllten Blüten im wilden Zustand (von K. YASUKAWA aufgefunden).

ersten Male einen solchen aufgefunden hatte. Der Stock, der trotz seinem ziemlich hohen Alter zwergig war, indem er anscheinend wiederholt durch das Volk abgeschnitten worden ist, zeigte drei gefüllte Blüten in ihrem üppigsten Stadium, zwei vergilbte Blüten, drei Fall-spuren der Blüten und fünf Blütenknospen. Eine von diesen Blüten kann als die typische sechswirtelige gefüllte Stammform genannt werden, wobei alle Glieder in jedem sechsgliedrigen Wirtel mit den-selben des benachbarten Wirtels alternieren. Die gefüllte Blüte be-steht dabei aus drei Kreisen Kronenwirtel, welche im Durchmesser 6,5 cm, 6 cm bzw. 4,5 cm betragen. Das Androecium und das Gynaeceum sind in ganz normalem Zustand geblieben (Fig. 2, rechts). Ausge-nommen die soeben genannte Vermehrung des Kronenwirtels stimmt diese gefüllte Blüte in allen Beziehungen mit der gewöhnlichen Blüte von *Gardenia jasminoides* überein. Bei allen anderen Blüten be-

obachten wir vier oder fünf Kreise Kronenwirtel, von denen einer aus den Staubblättern herrührt; jeder Kreis ist immer sechsspaltig, und
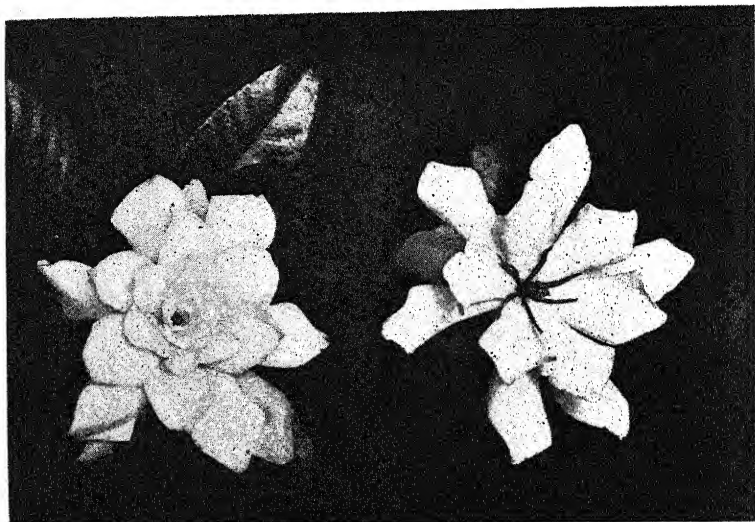


Fig. 2.   Stammform (rechts) und komplizierte Form (links) der gefüllten Blüte von *G. jasminoides* an einem und demselben Zweig.

der innerste ist häufig umgedreht.   Im soeben zitierten Fall sind die Staubblätter zum Teil oder gänzlich zu den Staminodien reduziert, und
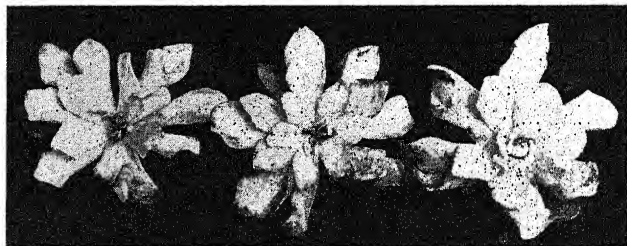


Fig. 3.   Drei verschiedene Füllungsstufen der gefüllten Blüte von *G. jasminoides*.

der Fruchtknoten enthält fast stets keine Samenanlagen (Fig. 3). Was ich ''kompliziertgefüllte Blüte'' nenne, besteht aus fünf sechsgliederigen Kreisen Kronenwirtel, und jedes Glied eines Kreises alterniert mit demselben des benachbarten.   Der innerste Kreis besteht dabei aus Staminodien, und übrigens ist sogar der Griffel blattartig umgewandelt (Fig. 2, links).

An einer andern Stelle des Hügels, die aus der soeben genannten 23 m nach Südwest entfernt ist, fanden wir auch einen Stock mit zwei im üppigsten Stadium befindlichen gefüllten Blüten und dem Fallspur einer Blüte. 1928 habe ich später zwei zu der Stammform gehörende gefüllte Blüten an demselben Stock angesehen, welche glücklicherweise befruchtet waren und rundliche gereifte Schoten produzierten (Fig. 4). Am 23. Juni desselben Jahres begegnete ich in der Nähe der obigen Stelle auch einem anderen Stock mit gefüllten Blüten.



Fig. 4. Gereifte Schoten an den Zweigen von wildwachsender *Gardenia* mit gefüllten Blüten.

Noch ein anderes Exemplar wurde am 8. Juli 1925 aufgefunden 8 m südwärts von da aus, wo 1922 mein Assistent einen Stock gefunden hatte. Nur ein schlanker Zweig mit zwei Blüten war an diesem kleinen Stock zu finden. So haben wir seit 1920 schon im Ganzen fünf wildwachsende *Gardenia*-Stöcke mit gefüllten Blüten auf dem genannten Hügel aufgefunden, und zwar etwa je einen Stock für jedes zweite Jahr. Drei neue neuerdings an dieser Stelle entdeckte Stöcke möchte ich hier noch anführen: zwei sind in der Nähe der schon obenerwähnten Stöcke, und ein ausgezeichneter Stock mit neun gefüllten Blüten ist davon 100 m entfernt gewachsen.

Es gibt noch bei uns eine andere gefülltblühende Art, *Gardenia radicans*, Thunb., wie schon erwähnt. Dieser Strauch ist kleiner als *Gardenia jasminoides*, Ellis und bei uns seit alter Zeit als eine Zierpflanze wohl bekannt. Alle seine Zweige hängen nach dem Boden herab; die kleinen Blätter, in der Mitte 4 cm lang und 1,2 cm breit, sind darüber gegenständig gestellt. Er steht im üppigsten Blühen in der

Regenzeit, die sich vom Ende Juni bis zum Anfang Juli erstreckt. Jede Blüte misst 5,2–6,3 cm im Durchmesser, dreikreisig in der Krone, von denen jeder Kreis sechsspaltig und der innerste etwas umgedreht ist. Die Staubblätter sind in meisten Fällen zum Teile zu Staminodien umgewandelt, das eine bleibt freilich unverändert. Der Fruchtknoten enthält sehr selten Samenanlagen.

## TABELLE I

### Durchmesser (in cm) der Blüten von *Gardenia*-Arten

| Gewöhnliche Blüten von *G. jasminoides* | Gefüllte Blüten von *G. jasminoides* | Gefüllte Blüten von *G. radicans* |
|---|---|---|
| 10,3 | 8,0 | 6,3 |
| 9,0 | 7,5 | 6,2 |
| 8,5 | 7,0 | 6,2 |
| 8,0 | 7,0 | 6,0 |
| 8,0 | 6,6 | 6,0 |
| 8,0 | 6,5 | 6,0 |
| 7,7 | 6,5 | 6,0 |
| 7,6 | 6,0 | 5,5 |
| 7,5 | 6,0 | 5,5 |
| 7,0 | 6,0 | 5,2 |
| Mittel 8,2 | 6,7 | 5,9 |

## TABELLE II

### Grösse (in cm) der Blattspreite von *Gardenia*-Arten

| *G. jasminoides* mit gewöhnlichen Blüten | | *G. jasminoides* mit gefüllten Blüten | | *G. radicans* | |
|---|---|---|---|---|---|
| Blattlänge | Blattbreite | Blattlänge | Blattbreite | Blattlänge | Blattbreite |
| 15,0 | 6,0 | 11,2 | 3,2 | 5,9 | 1,4 |
| 13,7 | 5,0 | 11,1 | 3,2 | 4,5 | 1,4 |
| 13,4 | 4,6 | 10,8 | 3,1 | 4,2 | 1,3 |
| 12,5 | 4,2 | 10,2 | 3,0 | 4,0 | 1,3 |
| 12,0 | 3,6 | 9,5 | 2,9 | 4,0 | 1,2 |
| 12,0 | 3,4 | 9,0 | 2,8 | 4,0 | 1,2 |
| 11,5 | 3,4 | 9,0 | 2,5 | 3,7 | 1,2 |
| 11,0 | 3,3 | 8,7 | 2,5 | 3,6 | 1,1 |
| 9,5 | 3,1 | 8,3 | 2,5 | 3,1 | 0,9 |
| 8,5 | 2,8 | 7,5 | 2,3 | 2,6 | 0,8 |
| Mittel 11,9 | 3,9 | 9,5 | 2,8 | 4,0 | 1,2 |

Wenn die Laubblätter der wildwachsenden Stöcke mit gefüllten Blüten etwas kleiner als dieselben von *Gardenia jasminoides* sind, kann man beide kaum scharf voneinander unterscheiden. Die Blüte der ersteren Pflanzen gleicht in ihrer Form und Grösse der von *Gardenia radicans*, doch wachsen ihre Zweige aufrecht, während dieselben von *radicans* mit sehr kleinen Blättern herabhängen.

Da die von uns aufgefundenen *Gardenia*-Pflanzen mit gefüllten Blüten nur in kleiner Zahl vorhanden und in ihrer Verbreitung sehr beschränkt sind, scheint es mir nicht wahrscheinlich zu sein, dass sie aus den gewöhnlichen *Gardenia jasminoides* vielmals hervorgekommen sind. Der 1923 gefundene Stock ist viel älter als alle anderen mit gefüllten Blüten; er trägt mehrere Blüten, welche verschiedene Füllungsstufen von dem einfacheren bis zu der komplizierten Form zeigen. Einige derselben, und zwar die Stammformen, sind geschlechtlich vollkommen, und dabei waren alle Blüten gefüllt, ohne eine einzige einfache Blüte. An einigen anderen Stöcken sind meistens zugleich einige kompliziertgefüllte Blüten beobachtet worden. Nun bezüglich des Ursprungs der wildwachsenden *Gardenia*-Pflanze mit gefüllten Blüten bin ich von der folgenden Ansicht. Es wäre nicht sehr lange, seit eine obenerwähnte Pflanze durch die Mutation zu Tage getreten war. Der Stock, welcher die geschlechtlich vollkommenen gefüllten Blüten trägt, d.h. was ich Stammform nenne, hat Samen produziert, und durch ein solches Individuum wäre diese eigentümliche Eigenschaft "gefüllt" an einige Nachkommen übertragen worden. Tatsächlich habe ich an einigen gefüllten Blüten die Samenproduktion beobachten können, und ich habe neuerdings zwei Gelbschoten aus den gefüllten Blüten erlangt (Fig. 4), und schon haben sich daraus 75 Keimlinge durch meine Hand entwickelt, obwohl ich noch nicht untersuchen kann, ob diese Eigenschaft vererbbar sei.[1] Man kann auch diesen Stock durch den Ableger leicht fortpflanzen lassen, und das ist vielleicht das beste Mittel, um die Geschichte der Entstehung der gut bekannten Pflanzen aus einer wilden Stammform nicht verschwinden zu lassen.

Indem die Zweige der in Rede stehenden, sehr selten anzutreffenden *Gardenia*-Stöcke wegen ihrer schönen gefüllten Blüten oft durch das

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(1) Indem bei den gefüllen Blüten von *Gardenia jasminoides* der Staubbeutel schon vor dem Blütenöffnen sich aufplatzt, muss ihre Selbstbefruchtung stattfinden. Überdies da ihre Blütezeit erst kommt, nachdem die der gewöhnlichen *Gardenia* mit einfachen Blüten schon vorüber ist, ist keine Gefahr vorhanden, dass die gefüllten Blüten durch den Staub der einfachen spontan befruchtet werden. Die Übertragung der gefülltblühenden Eigenschaft von *Gardenia jasminoides* auf ihre Nachkommen ist deshalb leicht verständlich.

Volk abgeschnitten werden mit keinem besonderen wissenschaftlichen Zweck, könnten sie binnen kurzer Zeit spurlos verschwinden, wenn nicht einige Schutzmassregeln gegen solche Schädigung vorgenommen würden. Glücklicherweise wurden sie dank der Empfehlung von Herrn Prof. M. MIYOSHI ganz neuerdings gesetzlich als Naturdenkmäler erklärt und in Schutz genommen. Ich möchte hier für die Bemühungen meines genannten verehrten Lehrers meinen herzlichen Dank aussprechen.[1]

FÜNFTE HÖHERE SCHULE,
KUMAMOTO, JAPAN

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(1) Diese gefülltblütige Pflanze trägt den Namen *Gardenia jasminoides*, ELLIS var. *ovalifolia*, NAKAI. Vgl. NAKAI & KOIDZUMI, Trees and Shrubs indigenous in Japan Proper Vol. **1**, 1927, S. 520. (Japanisch).

# Cytological Studies on the Pollen-formation of the Hybrids between *Triticum* and *Aegilops*

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## Table of Contents

## Material and Methods

The material used in the present study is as follows:

| Species | Agronomic Varieties |
|---|---|
| *Triticum dicoccum*, SCHÜBL. | U.A.C. (Utsunomiya Agricultural College), No. 1. |
| | Blé de Pologne ou d'Astrakan. |
| ,,    *polonicum*, L. | |
| *Aegilops cylindrica*, HOST. | |
| ,,    *ovata*, L. | |

The numbers of chromosomes in all of these species were ascertained by the writer's former (1928, 1929) as well as present studies

to be 14 or 28 (either haploid or diploid). Among these species the crosses were made according to the following combinations:

(1) *Aegilops cylindrica* × *Triticum dicoccum*
(2) ,, *ovata* × ,, *polonicum*.

In (1) 5 $F_1$ individuals were raised from 83, and in (2) a single $F_1$ plant was got from 19 crossings. All $F_1$ plants grew vigorously and showed intermediate state of the parents for most characters. Each individual was covered by a frame of lawn to protect against the cross-pollination. All individuals presented the complete sterility, because 4944 and 965 spikelets of $F_1$ of (1) and (2) respectively did not produce any single kernel. The P.M.C.-s of these $F_1$ plants were observed in BELLING's acetocarmine.

## Results of Observation

### I. *Aegilops cylindrica* × *Triticum dicoccum*

#### 1. The First Meiotic Division

At metaphase of the first division 28 univalent chromosomes are observed, which correspond to the sum of the haploid numbers of the two parents. In very rare cases all of them which are arranged on or near the equatorial plane form a nearly normal equatorial plate (Fig. 1). In most of the P.M.C.-s, however, all chromosomes are arranged irregularly in a cell, some on the equatorial plane, some at the poles and others between the equatorial plane and the poles (Fig. 2). These 28 univalents are usually separated clearly from each other, and the formation of compact gemini is never observed. But in some P.M.C.-s it is observed in metaphasic or anaphasic views, that two univalent chromosomes of about the same size, are connected longitudinally. The number of such connected groups of chromosomes in one P.M.C. is counted to be 1–4 (Figs. 3, 4, 5, 6). In Fig. 5 each univalent chromosome is already longitudinally split. The relative frequency of the numbers of connected groups in one P.M.C. is shown in the following table:

| Number of connected groups of chromosomes in one P.M.C. | *1* | *2* | *3* | *4* |
|---|---|---|---|---|
| Number of P.M.C.-s | 89 | 26 | 2 | 1 |

n=118

Rarely three chromosomes of about the same size are observed to be connected longitudinally (Fig. 7). In this P.M.C., other two chromosomes showing about the same size are also found connected with each other.

The above stated groups of chromosomes may be said to be bivalent or trivalent ones composed of homologues. But in some P.M.C.-s it is ascertained by the observation made with the strict attention to the foreshortening of chromosomes, that the size of the individual ones is not the same in one and the same connected group. In the one shown in Fig. 8, in which they are drawn as if situated in the plane of the drawing paper, the upper one is longer than the lower. As the degree of foreshortening is quite small and about the same in both chromosomes, the upper one is certainly longer than the lower. In the anaphasic side view, as this Fig. is, it is possible that the material of connected chromosomes is stretched by the tension coming from both poles. But taking into account the similar breadth of two chromosomes under consideration, it seems difficult to recognize that this connected group is made of two chromosomes which are of equal size. Thus such a connected group may not be said to be a bivalent chromosome composed of homologues, and it must be regarded properly as a bipartite chromosome made up of two non-homologous chromosomes.

In the next stage each chromosome is longitudinally split (Figs. 5, 9). The split halves of some univalent chromosomes are separated to different poles, while those of other univalents go to either one pole, arranging side by side without being separated (Fig. 10). The distribution of chromosomes to both poles takes place at random. In Fig. 10 we observe three split halves which are separated from their partners to be carried to different poles. But in some cases the number of split halves of such kind is greater. In one case about twelve split halves were observed in a polar view of the first anaphasic figure. The formation of the tripolar spindle is sometimes observed (Fig. 11), and the chromosomes are accordingly distributed to three poles. Some chromosomes are observed to lag at the first division. In certain cases one of the two dyad cells formed by the first division contains all chromosomes of the P.M.C., and another none. This condition can be seen in Fig. 12, in which the nucleus is in an interkinetic stage. I have observed a giant P.M.C. showing spherical shape and about twice the volume of a normal P.M.C. In this P.M.C. the chromosomes, whose number much exceeds the diploid one, were arranged in a group at about the centre of the cell and showed approximately the metaphase

of the first division. But, owing to the rather compact arrangement of chromosomes and the unfavourable state of staining at the time of observation, it was difficult to observe them precisely. The possibility that this cell was a tetraploid P.M.C. is not excluded if we consider the fact that it was observed in the meiosis in $F_1$ of *A. ovata* × *T. polonicum*, which I will describe later.

## 2. The Second Meiotic Division

The second meiotic chromosomes are longer and more slender than the first ones. At metaphase of the second division both the dyad and monad chromosomes are observed, which corresponds to the chromosome behaviour in the first division. In Fig. 13 we observe 8 dyad and 14 monad chromosomes, and in Fig. 14 17 dyad and 6 monad ones. Fig. 15 shows the second metaphase or very early anaphase of a P.M.C., in which the quite uneven distribution of chromosomes occurred in the first division. In this P.M.C. the dyad cell at the right contains most of the chromosomes, some of them being monads and others dyads. The number of monads counted is about 11 and that of dyads 16. At the place outlined by a curve in the Fig. the chromosomes are arranged rather compactly, and difficult to be observed clearly. In the dyad cell at the left of the Fig. we observe only two monad chromosomes.

At the second anaphase the split halves of the dyad chromosomes are usually separated and distributed to different poles, while the monad chromosomes go to either one pole irregularly. But in some cases the split halves of dyad chromosomes are not separated from their partners and go to either one pole, arranging side by side, which is the cause of the existence of dyad chromosomes in the tetrad cells. Fig. 16 shows the second division of a P.M.C., in which three cells were formed either by the tripolar spindle or by the irregular distribution of chromosomes in the first division. The lagging of certain chromosomes is also observed in the second division as in the first.

Owing to the lagging chromosomes in the first and the second division, the polyspory showing 5–7 microspores and the extra nuclei in microspores are brought about. The size of the premature pollen grains differs greatly, and in some cases dyad or giant pollen grains are produced as can be seen in Fig. 17. In this Fig. N presents the size and shape of the pollen grains which are formed most frequently.

### 3.   The Formation of the Restitution Nucleus

In certain P.M.C.-s the formation of the restitution nucleus in the sense of ROSENBERG (1927) was observed (Figs. 18, 19).   Fig. 19 shows a metaphasic plate following the stage shown in Fig. 18.   In Fig. 19 almost all chromosomes are arranged on the equatorial plane.   In this Fig. 24 chromosomes are clearly counted, and besides there are groups consisting probably of a few chromosomes which can not be counted individually.   The outlines of these groups are shown by the curves in this Fig.   All chromosomes which are observed are longer and more slender than the first metaphasic chromosomes and present the nature of the interkinetic ones.   This Fig. can be regarded as to present the metaphasic plate of the restitution nucleus containing 28 chromosomes.   All other P.M.C.-s observed in the same anther present the second meiotic telophase, except one which lies adjacent to that under consideration and shows about the same state regarding the shape, number and arrangement of chromosomes as that shown in Fig. 19.   Owing to the homotypic division occurring on the chromosomes of such restitution nucleus the dyad cells containing the diploid number of chromosomes and consequently the diploid pollen grains can be produced.   At the second anaphase and telophase two chromosome groups are in some cases surrounded by a nuclear membrane in a dyad cell, as can be seen in Fig. 20.   The content of such nucleus must be various as the chromosome distribution in the first division is irregular.   In the second division the protoplasmic portions of the P.M.C. containing no chromosomes are sometimes cut off by the cell membrane.

## II.   *A. ovata* × *T. polonicum*

### 1.   The First Meiotic Division

In the first division 28 univalent chromosomes are observed.   Often the P.M.C.-s in which all chromosomes are arranged on or near the equatorial plane formig the nearly normal metaphasic plate are observed (Fig. 21).   The frequency of the occurrence of such kinds of P.M.C.-s is considerably larger here than in $F_1$ of *A. cylindrica* × *T. dicoccum*.   In the majority of P.M.C.-s, however, 28 univalents are arranged irregularly (Fig. 22), and the chromosomes never form the compact gemini, though only in some cases two chromosomes of about the same size are connected longitudinally in metaphase or

anaphase. The number of such connected groups of chromosomes is
1–2 for each P.M.C. (Figs. 23, 24). The relative frequency of the
numbers of connected groups in one P.M.C. is shown in the following
table :

| Number of connected groups of chromosomes in one P.M.C. | 1 | 2 |
|---|---|---|
| Number of P.M.C.-s | 89 | 9 |
| n = 98 | | |

In certain cases one chromosome in a connected group is much
larger than the other. In that in Fig. 25 seen at about the center of the
P.M.C., the lower chromosome in the group appears to be shorter than
the upper, though they were drawn, as if both were situated on the
plane of the drawing paper, and moreover the degree of foreshortening
of the former is smaller than that of the latter, so that there is
evidently the difference in their lengths. Their breadths are however
not different from each other, so it may be more reasonable to regard
this connected group as a bipartite chromosome formed by the non-
homologues, rather than to consider it as a bivalent one formed by
the homologues.

In the next stage the chromosomes are longitudinally split (Fig. 26).
The split halves of univalents are distributed together to either one
pole without being separated, or they are separated from each other
and go to different poles. Usually less than about 8 univalents distri-
bute their split halves to different poles (Fig. 27), but in some cases
this mode of chromosome distribution occurs on a larger number of
univalents, as can be seen in Fig. 28. In this Fig. the places outlined
by the curves contain some chromosomes which are not clearly counted.
In Fig. 29 a chromosome lies near the pole while all other ones are
arranged on or near the equatorial plane. In Fig. 30 all are arranged
on or near the equatorial plane, and the split halves of an univalent
are already separated and being carried to different poles. In these
two Figs. lastly stated all the chromosomes arranged in the group are
not drawn. The split halves going to different poles which are drawn
in outlines only in Fig. 28 may possibly indicate that they are derived
from the univalents which were formerly arranged on or near the
equatorial plane in the manner observed in Figs. 21 and 30. And the
chromosomes presented in black in Fig. 28 may be regarded as those
which were arranged from the beginning much apart from the equatorial
plane. The reason is that the separation of the split halves of uni-
valents by the spindle fibre to be carried normally to different poles

may take place more easily on the univalents arranged on or near the equatorial plane, than on the univalents located much apart from the same plane. If this is true, it is possible that in the P.M.C.-s such as shown in Figs. 21 and 30 the split halves of all the 28 univalents are separated and distributed to different poles. It may be not impossible, therefore, to expect here the dyad cells having 28 chromosomes, and consequently the dyad pollen grains. Quite often tri- and multi-polar spindles are also observed (Fig. 31). The lagging of certain chromosomes is seen in many P.M.C.-s.

I have found in some cases the connected or fused states of two or more P.M.C.-s. Here we may distinguish two categories. In one of them the formation of the cell-membrane takes place to some extent in the division of archesporial cells to form the P.M.C.-s, though the cell-membrane does not completely separate the individual P.M.C.-s. Consequently the P.M.C.-s which are formed are connected to each other in a dumb-bell- or bead-shape as will be seen in Fig. 32, a. In this Fig. four P.M.C.-s are connected, and three P.M.C.-s at left are in their first meiotic telophase, while one P.M.C. at right presents early anaphase of the first division as shown in Fig. 32, b. In this Fig. the chromosomes are arranged rather compactly, so their number is difficult to be counted. But we observe there somewhat over twenty univalent chromosomes, their split halves being already or not yet separated from each other. This P.M.C. may possibly contain the diploid number of univalent chromosomes. It seems probable that these connected P.M.C.-s are derived from an archesporial cell in which two successive nuclear divisions occurred without being accompanied by the formation of complete cell-membrane.

In another category of connected or fused states of P.M.C.-s the formation of the cell-membrane does not take place at all in the division of the archesporial cell to form P.M.C. Consequently, the giant P.M.C. of about the spherical shape is produced as can be seen in Fig. 33. This Fig. presents the first metaphase, and 52 univalent chromosomes are clearly counted. Besides these there are probably a few chromosomes which can not clearly be counted owing to their rather compact arrangement. The outlines of the places where such uncountable chromosomes are located are shown by the curves in the Fig. 48 chromosomes out of 52 are arranged, together with the uncountable chromosomes, on more than a single optical plane forming a group near the center of the P.M.C. Some of these chromosomes show clearly the longitudinal split. 4 chromosomes are located apart from this

group.  It can probably be said that this giant P.M.C. contains 56, i.e.,
the tetraploid number of chromosomes.  They are composed of two
chromosome sets of *Aegilops* and of *Triticum* though their mating
could not be observed at all.  This probably is owing to the fact that
the two nuclei formed by the nuclear division of an archesporial cell
which produced this giant P.M.C. were located near to each other, and
in each of them the first meiotic prophase proceeded independently,
after which the disappearance of the nuclear membrane took place.

## 2.  The Second Meiotic Division

The second meiotic chromosomes are longer and more slender than
the first.  At metaphase some of them are dyads and others monads,
and this corresponds to the chromosome behaviour in the first division.
In Fig. 34 12 dyad and 2 monad chromosomes are represented.  Their
behaviour in the second anaphase is the same as that in *A. cylindrica* ×
*T. dicoccum* F$_1$.

In some cases all or almost all chromosomes of the second division
appear as the monads.  A P.M.C. shown in Fig. 35 has the usual size
and is divided into three cells.  Cell *a* is a single cell, and there are
two cells, *b* and *c* at the right of this cell in different optical planes.
Cell *a* contains 27 chromosomes, cell *b* 23 clearly countable and pro-
bably a few uncountable ones, while cell *c* shows only 3.  All chromo-
somes which are clearly observable are rather slender and each of
them does not present the longitudinal split.  This P.M.C. may show
the second division following the first division in which the split halves
of all or almost all univalent chromosomes were separated from their
partners and carried to three different poles or places owing either to
the tripolar spindle or the irregular distribution of chromosomes.
When we consider this fact, it might not be perhaps impossible that
the first meiotic division of the P.M.C. will take place in some cases
homotypically on all univalent chromosomes.

Fig. 36 presents the second division of a P.M.C. in which three
cells were formed by the tripolar spindle or by the irregular distribu-
tion of chromosomes in the first division.  Frequently the polyspory
showing 5–9 microspores occurs, and in the latter the extra nuclei are
observed.  The size of the pollen grains shows great difference, and
the dyad or giant pollen grains are sometimes observed as can be seen
in Fig. 37.  In this Fig. N presents the shape and size of pollen grains
which are most frequently produced.

## Discussion

In the cases where the bivalent chromosomes appear in the meiosis of $F_1$ of related species, it is at present generally admitted that these bivalents may be formed from the homologous chromosomes by auto- or allo-syndesis. THOMPSON (1926) assumed, chiefly from the modes of chromosome mating in the meiosis of species hybrids in *Triticum* and of generic hybrids between *Triticum* and *Aegilops*, that the composition of the haploid set of chromosomes is ABC in *T. vulgare*, AB in species of Emmer group of *Triticum*, A in *T. monococcum* and CD in species of *Aegilops*. And in each of these component sets A, B, C, and D 7 chromosomes were esteemed to be contained. Analogous conceptions were stated by SAX (1928) and KIHARA (1928), and according to them the Vulgare group of *Triticum* has ABC, and the Einkorn group A or B. SAX (1928) assumed that *A. cylindrica* or *A. ovata* has C and D. KIHARA and NISHIYAMA (1928) called the one set other than A and B of Vulgare group D, as this set carries the characters of Dinkel group.

BLEIER (1928) and SAX (1928) reported that the bivalent chromosome was not formed in the meiosis of $F_1$-s between species of Emmer group and *A. ovata* or *A. cylindrica*. In my present study also the compact geminus was never formed in the meiosis in $F_1$-s of *A. cylindrica* × *T. dicoccum* and *A. ovata* × *T. polonicum*. Considering these facts, it seems that neither *A. cylindrica* nor *A. ovata* does contain A and B. BLEIER (1928) observed no bivalent chromosome in the meiosis of $F_1$ between *A. ovata* and *T. villosum* which has 7 haploid chromosomes. This may show that *A. ovata* has neither A nor B of Einkorn group. On the other hand, the fact that there was formed no compact bivalent chromosome in the meiosis of the hybrids of these authors and of the writer may indicate that *A. ovata* and *A. cylindrica* may probably be no autotetraploid species.

SAX (1924), BLEIER (1928) and KAGAWA (1928) observed that 7 bivalent chromosomes were formed in the meiosis of the hybrids between *A. cylindrica* and *T. vulgare* or *T. Spelta*. *A. cylindrica* may not possess, as was stated above, A and B, so that it may be assumed that *A. cylindrica* has C, and this mates with C of Vulgare group forming here 7 bivalent chromosomes. KIHARA and NISHIYAMA (1928) observed the appearance of trivalent chromosomes in the meiosis of the $F_1$-generations in *T. dicoccum* × *T. monococcum*, *T. aegilopoides* × *T. dicoccum* and *T. Spelta* × *T. aegilopoides*. These authors assumed,

from the number of trivalents that appeared, that there are at most 3 pairs of chromosomes having affinity to mate with each other between A and B and also between B and D, as was named by them, though between A and D no such chromosomes seem to exist. KIHARA (1928) also assumed, from the fact that 6 bivalent chromosomes can be formed in the meiosis of $F_1$ between *A. ovata* and species of Emmer group, that there may be 3 pairs of homologous chromosomes in *A. ovata*.

When we consider my results, it seems not unreasonable to think that (1) at most 4 bivalent chromosomes observed in the $F_1$ meiosis of *A. cylindrica* × *T. dicoccum* may have been formed by the autosyndesis between A and B, and also by the allosyndesis between B and C (D of KIHARA and NISHIYAMA), and that (2) the trivalent chromosomes observed rarely in my material may have been formed by three chromosomes, each of which belongs to A, B and D or B, C and D in the sense of THOMPSON. At most 2 bivalent chromosomes observed in the $F_1$ meiosis of *A. ovata* × *T. polonicum* may have been formed by the autosyndesis of the chromosomes of either of the two parents.

BLEIER (1928) reported in the $F_1$ meiosis of *A. ovata* × *T. vulgare*, in which the compact gemini were not observed, that at most 3 chromosome pairs, in each of which 2 chromosomes were connected longitudinally, were observed in certain anaphasic side views of P.M.C.-s, which can be expected from what is stated above. But BLEIER observed, in the first meiotic anaphase in $F_1$ of *A. ovata* × *T. monococcum*, that at most 5 pairs of chromosomes, in each of which 2 chromosomes were connected longitudinally, appeared, though often 21 univalent chromosomes were observed there. This fact seems to be unfavourable to the conception that the haploid set of chromosomes is composed of A in Einkorn group, AB in Emmer group, ABC in Vulgare group and CD in *A. ovata*. According to KAGAWA (1927, 1929) there are, in the somatic cells of *T. monococcum*, only two homologues in each chromosome category classified by the size and shape of chromosomes. And *A. ovata* can, according to the assumption of KIHARA (1928), form at most 3 pairs of chromosomes. The appearance of at most 5 pairs of chromosomes in the above stated hybrid of BLEIER may be owing to the fact that some external conditions affected the mode of formation of bivalents among the chromosomes of *A. ovata* producing here by autosyndesis a larger number of bivalents than that assumed by KIHARA, or else the allosyndesis between chromosomes of *A. ovata* and *T. monococcum* may have played some rôle here.

The above assumptions can be understood under the supposition

that the chromosomes which form a pair or which are connected longitudinally are homologous, which may in most cases be correct. But the longitudinal connection of chromosomes in the hybrids between *Aegilops* and *Triticum* may sometimes take place between non-homologous chromosomes, as can be seen in the examples in the writer's material in which the connection of chromosomes of different size is shown. KIHARA and NISHIYAMA (1928) observed in the meiosis of $F_1$-generations in *T. dicoccum* × *T. monococcum* and *T. aegilopoides* × *T. dicoccum* that two bivalents, in each of which two chromosomes was longitudinally connected, were connected again longitudinally forming here a chain of four chromosomes. They further observed that a bivalent, in which two chromosomes were connected lengthwise, was connected in a form of chain with three chromosomes which were connected lengthwise. Considering these facts also it can be admitted that the longitudinal connection may take place between two or more non-homologous chromosomes.

The longitudinal connection between chromosomes belonging to different pairs and the formation of bi- and multi-partite chromosomes were reported also by CLELAND (1922) in *Oenothera*, by STOW (1927) in *Tradescantia*, by MATSUDA (1928) in *Petunia* and by others in various plant forms. JØRGENSEN (1928) states, in the chromosome studies on polyploid individuals in *Solanum*, that the mode of chromosome mating can not be relied upon as indicative of the identity of chromosomes. MEURMAN (1928) observes in the first meiotic division of the hybrid species *Ribes Gordonianum*, *R. Culverwellii* and *R. Carrièrei*, that allosyndesis takes place between chromosomes of different size producing here the pairs, in which each partner shows a different size from the other. When we discuss the influence of the similarity or homology of chromosomes of related species concerning the mode of chromosome pairing or connection in the hybrid meiosis, it is necessary on the one hand to pay precise attention to the chromosome size, and on the other to elucidate the variation of the mode of chromosome pairing or connection which may be presented under different external conditions. In studying the problem further we should make the precise comparison of chromosomes between related species regarding their size and shape.

In the first meiotic division of the $F_1$ hybrids between *Aegilops* and *Triticum* which are reported up to the present there are some cases in which the longitudinal division of univalent chromosomes takes place, while in other cases the division does not occur. Recently BLEIER

(1928) stated that he could not observe the division of univalents in the first meiotic division of $F_1$-s of *A. ovata* × *T. dicoccoides* and *A. ovata* × *T. durum*.   He observes in the meiosis of $F_1$ between *A. cylindrica* and *T. durum*, that almost all univalents are arranged on the equatorial plane at the first division, and go to either one pole without division. SAX (1928) reports, in the meiosis of P.M.C. in $F_1$ of *A. ovata* × *T. dicoccum*, that the univalent chromosomes go to poles probably undivided in the first division.   The behaviour of univalents in the meiosis of my $F_1$-s between *A. ovata* or *A. cylindrica* and Emmer group differs therefore considerably from these results.

Concerning the formation of diploid or polyploid germ cells some possible causes were hitherto reported by investigators.   It was not possible in my material to find actually the figures showing the split halves of each univalent separated to different poles of the first division to form dyad cells containing the diploid number of chromosomes.   But the possibility of occurrence of such a phenomenon may not be excluded considering Figs. 28, 30 and 35 observed in $F_1$ of *A. ovata* × *T. polonicum*.   The chromosome behaviour of such kind is a case of nonreduction stated by BELLING (1925).   SAX (1928) found by the chromosome observation of the back cross, ($F_1$ of *A. ovata* × *T. dicoccum*) × *T. dicoccum*, that all fertile egg cells produced from this $F_1$ contained 28 chromosomes.   He assumed, considering the fertility of the $F_1$ which was somewhat high, that the 28 chromosomes in these egg cells were brought about by the non-reduction of chromosomes, instead of being the result of the random assortment of chromosomes.

In the case where all chromosomes are contained, owing to their uneven distribution, in one of the two dyad cells as was shown in Fig. 12 of $F_1$ meiosis of *A. cylindrica* × *T. dicoccum*, the omission of the second division may bring about here the tetraploid pollen grain.   But if the second division takes place in the dyad cell such as stated above, diploid pollen grains will be formed, as all chromosomes are dyads and accordingly their homotypic division may be expected here.

Dyad cells containing the diploid number of chromosomes and consequently the diploid pollen grains can be produced by the homotypic division of the restitution nucleus observed in the $F_1$ meiosis of *A. cylindrica* × *T. dicoccum*.   In recent years the occurrence of the restitution nucleus in the hybrids was reported by a number of investigators, for example, by KARPECHENKO (1924, 1927, 1928) and SHIMOTOMAI (1928) in $F_1$ and $F_2$ individuals of generic hybrids between

*Raphanus* and *Brassica*, by TISCHLER (1927) in *Ribes Gordonianum* which is the hybrid between *R. sanguineum* and *R. aureum*, by BUXTON and NEWTON (1928) in $F_1$ of species hybrid of *Digitalis*, and by SCHWEMMLE (1928) in tetraploid branches of a $F_2$ plant of species hybrid of *Oenothera*. The formation of a restitution nucleus may probably be one of the most frequent processes to produce diploid pollen grains. The fusion of two nuclei was also observed in the second division in $F_1$ of *A. cylindrica* × *T. dicoccum*. But the chance to form diploid pollen grain by such a process must be rare as the distribution of chromosomes is irregular in the first division.

RANDOLPH and McCLINTOCK (1926) observed in *Zea Mays* the P.M.C.-s containing a diploid number of bivalent chromosomes. HÅKANSSON (1927) observed the P.M.C.-s containing a tetraploid number of chromosomes in the hybrid between *Oenothera Lamarckiana* and *O. biennis*. Generally in the cases where the double number of bivalent chromosomes is contained in a P.M.C. the formation of diploid pollen grains may be expected by the normal behaviour of chromosomes. KARPECHENKO (1927) observed in $F_1$ of *Raphanus sativus* × *Brassica oleracea* the chromosome figures which show the possibility that the tetraploid pollen grains can be produced from a P.M.C. containing two diploid nuclei.

The tetraploid giant P.M.C. found in $F_1$ of *A. ovata* × *T. polonicum* shows features somewhat resembling the above cited case of KARPECHENKO. But the chromosome behaviours which may be expected in such a P.M.C. of my material are complex, and all the modes of chromosome behaviour shown by the ordinary diploid P.M.C.-s of $F_1$ of this combination of parents can probably be also expected here. Thus the possibility forming the pollen grains containing the tetraploid number of chromosomes can be said to be quite scarce, though not absolutely wanting.

## Summary

1. In the $F_1$ of *Aegilops cylindrica* × *Triticum dicoccum* and of *A. ovata* × *T. polonicum* 28 univalent chromosomes appeared at the first meiotic division of P.M.C.-s. These univalents were usually clearly separated from each other, and the formation of compact gemini was never observed.

2. In the metaphase or anaphase of $F_1$ P.M.C.-s of *A. cylindrica* × *T. dicoccum* two chromosomes of about the same size were some-

times connected longitudinally. The number of such connected chromosome groups in a P.M.C. was 1-4. Rarely three chromosomes of about the same size were connected lengthwise.

3. Similarly in the metaphase or anaphase of $F_1$ P.M.C.-s of *A. ovata* × *T. polonicum* two chromosomes of about the same size were in some cases connected longitudinally. The number of such connected chromosome groups in a P.M.C. was 1–2.

4. The above stated connected chromosome groups found in both $F_1$ hybrids may probably be the bivalent or trivalent chromosomes composed of homologues. But in certain cases two non-homologous chromosomes showing considerable difference in size with each other were connected lengthwise to form bipartite chromosomes in the first division of both $F_1$ hybrids.

5. The formation of the restitution nucleus was observed in the first division of $F_1$ of *A. cylindrica* × *T. dicoccum*, and the production of diploid pollen grains can be expected here.

6. Some other meiotic figures showing the modes of chromosome behaviour which may possibly result in the formation of diploid or tetraploid pollen grains were observed in both $F_1$ hybrids, and discussions were made regarding them.

7. In $F_1$ of *A. ovata* × *T. polonicum* the connection or fusion of P.M.C.-s was sometimes observed. In one of the cases the tetraploid number of univalent chromosomes was recognized to be contained in a giant P.M.C. of about the spherical shape.

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## Explanation of Plates XXXII-XXXIV

All figures in Plates XXXII-XXXIV are drawn with the aid of ABBE's large camera using ZEISS homogene immersion 1/12, DD and compensation oculars 6, 8 and 12.

### Plate   XXXII

Figs. 1–14.   F₁ of *Aegilops cylindrica × Triticum dicoccum.*   × 1540.
Figs. 1–12.   First meiotic division.   Fig. 1 polar view, Figs. 2–10 side views.
Fig. 1.   28 univalents arranged on or near the equatorial plane.
Fig. 2.   28 univalents arranged irregularly.
Fig. 3.   One bivalent and 26 univalents.
Fig. 4.   Two bivalents and 24 univalents.
Fig. 5.   Three bivalents and 22 univalents.
Fig. 6.   Four bivalents and 20 univalents.
Fig. 7.   One trivalent, one bivalent and 23 univalents.
Fig. 8.   One bipartite chromosome and 26 univalents.
Fig. 9.   Longitudinal split of univalents.
Fig. 10.   Behaviour of split halves of 28 univalents.
Fig. 11.   Tripolar spindle.
Fig. 12.   Interkinetic nucleus in one of the two dyad cells containing all chromosomes of the P.M.C.
Figs. 13–14.   Second meiotic division.
Fig. 13.   8 dyad and 14 monad chromosomes.
Fig. 14.   17 dyad and 6 monad chromosomes.

### Plate   XXXIII

Figs. 15–20.   F₁ of *A. cylindrica × T. dicoccum.*   × 1540 except Fig. 17.
Figs. 15–16.   Second meiotic division.
Fig. 15.   Second division showing that the irregular chromosome distribution of considerable extent has occurred in the first division.
Fig. 16.   Second division of three nuclei formed either by the tripolar spindle or by the irregular distribution of chromosomes in the first division.
Fig. 17.   Premature pollen grains.   × 560.
Fig. 18.   Restitution nucleus, dumb-bell-shaped.
Fig. 19.   Metaphasic plate in the division of restitution nucleus.
Fig. 20.   Fused nucleus at telophase of the second division.
Figs. 21–27.   F₁ of *A. ovata × T. polonicum.*   × 1540.   Fig. 21 polar view, others side views.
Fig. 21.   28 univalents arranged on or near the equatorial plane.
Fig. 22.   28 univalents arranged irregularly.
Fig. 23.   One bivalent and 26 univalents.
Fig. 24.   Two bivalents and 24 univalents.
Fig. 25.   One bipartite chromosome and 26 univalents.
Fig. 26.   Longitudinal split of 28 univalents.
Fig. 27.   Behaviour of split halves of univalents.

## Plate  XXXIV

Figs. 28–37.   F₁ of *A. ovata* × *T. polonicum*.

Figs. 28–31.   First meiotic division.   × 1540.   Figs. 28–30 side views.

Fig. 28.   Behaviour of split halves of univalents.

Fig. 29.   All univalents except one are located on or near the equatorial plane.

Fig. 30.   All univalents are located on or near the equatorial plane, and the split halves of a single univalent are on their way to different poles.

Fig. 31.   Multipolar spindle.

Fig. 32, a.   Connection of four P.M.C.-s.   × 900.

Fig. 32, b.   One P.M.C. at the extreme right in Fig. 32, a.   × 1540.

Fig. 33.   Giant tetraploid P.M.C.   × 1430.

Fig. 34.   Second division.   12 dyad and 2 monad chromosomes.   × 1540.

Fig. 35.   Three cells formed from a P.M.C. in each of which all chromosomes clearly observed are monads.   × 2140.

Fig. 36.   Second division of three nuclei formed either by the tripolar spindle or by the irregular distribution of chromosomes in the first division.   × 1540.

Fig. 37.   Premature pollen grains.   × 560.
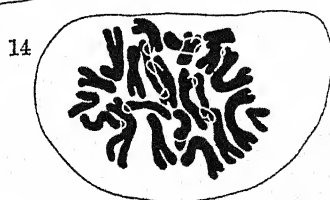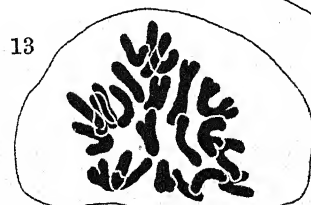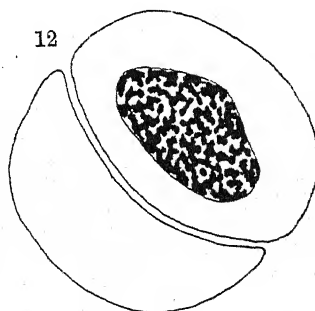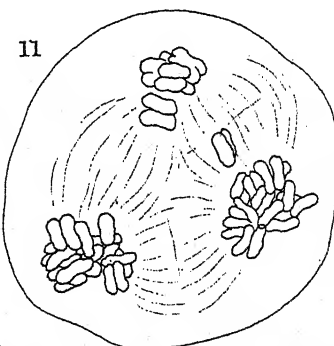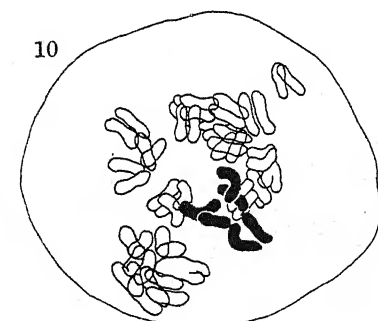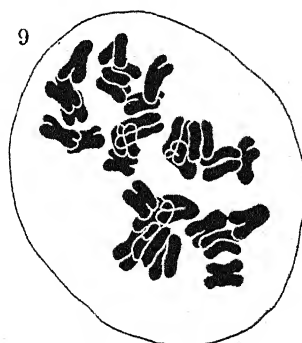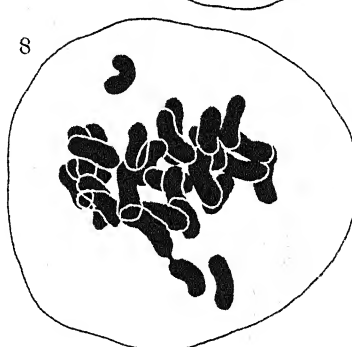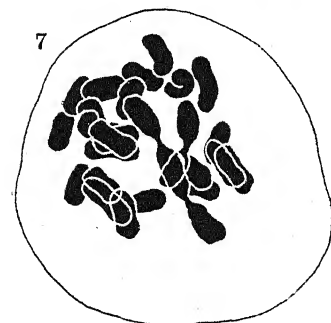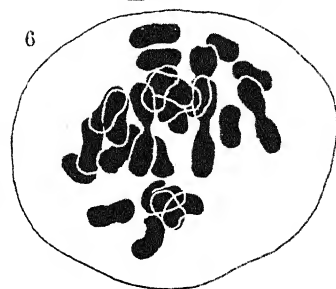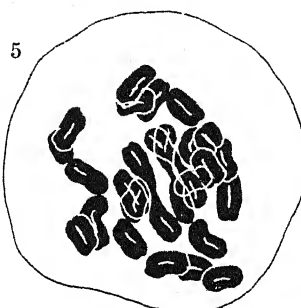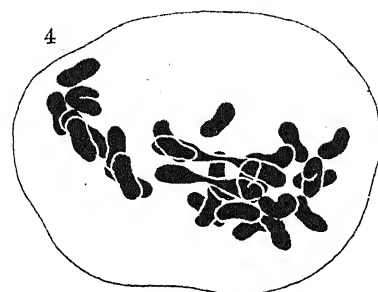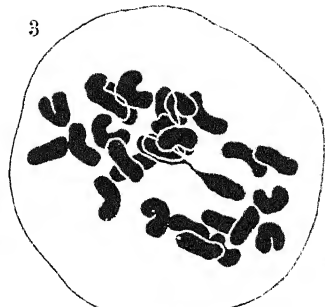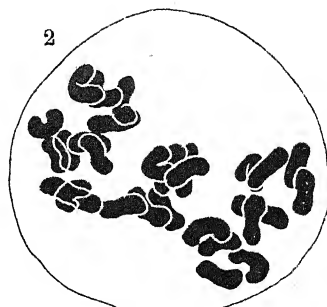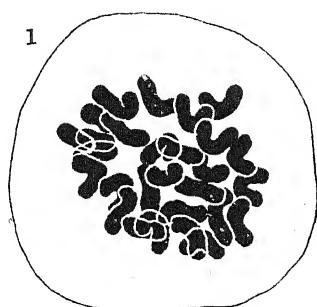
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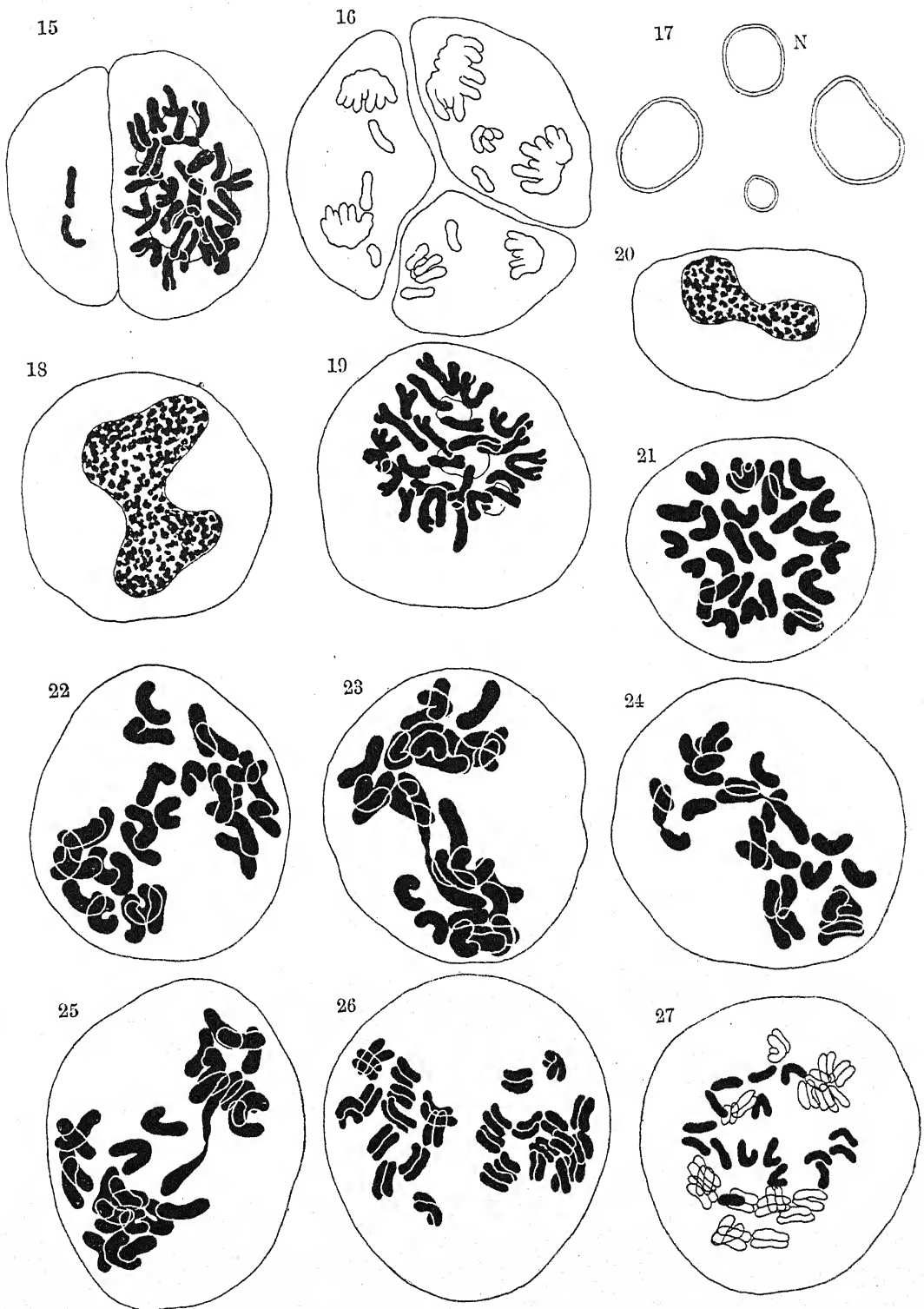
PLATE XXXIII

PLATE XXXIV
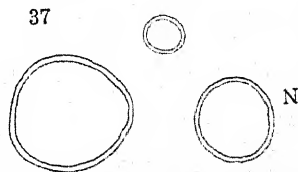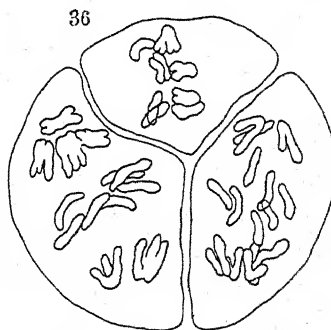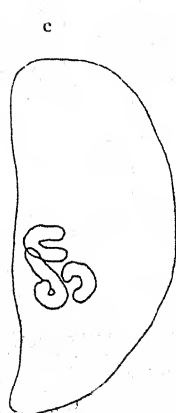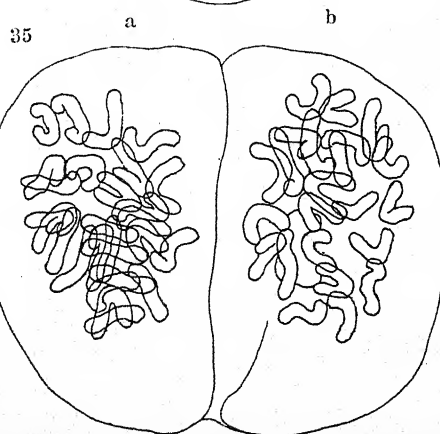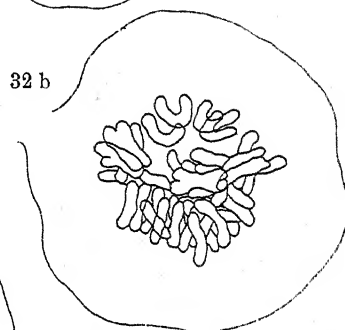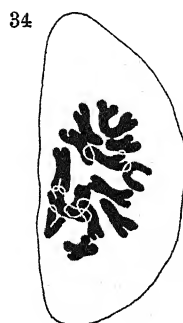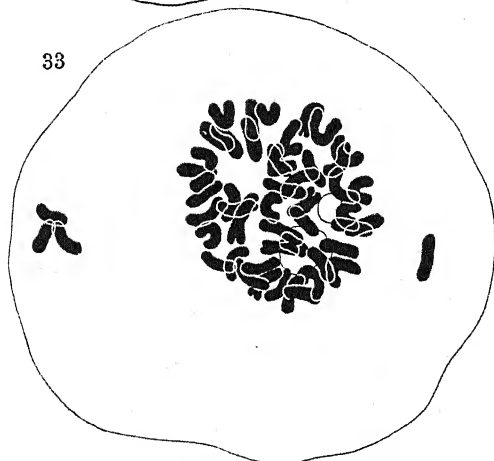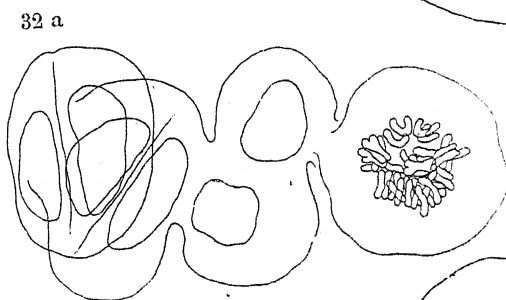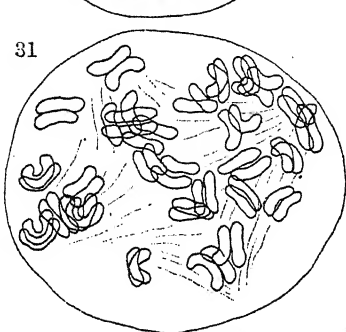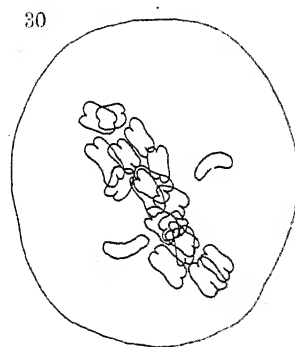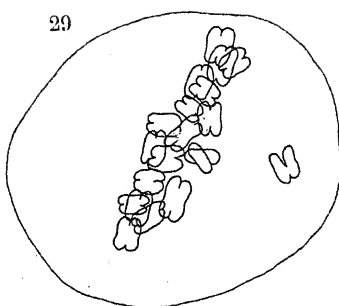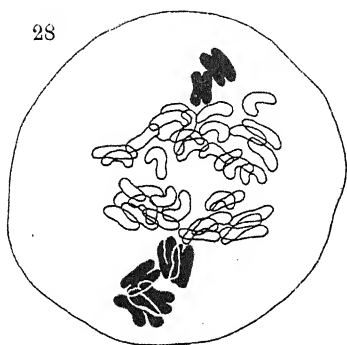
# On the Phylogeny of Some Cereals and Related Plants, as Considered from the Size and Shape of Chromosomes

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## Table of Contents

## Introduction

In the present study the comparison of chromosomes in certain species of *Triticum*, *Aegilops* and *Hordeum* was made, and the discussion on the phylogenetic relationships of the related species was accordingly done. The comparison of chromosomes was chiefly made according to their size, but their shape was also used for this purpose. For determining the size of chromosomes their foreshortening must be strictly considered, as otherwise it may bring about great errors in estimating their length. As was stated in the writer's work on *Triticum* and *Aegilops* (1929, a), the chromosomes in root-tips treated by the dilute

solution of chloral hydrate appear much shorter and thicker than those in normal root-tips, and the amount of foreshortening is usually much less in the former than in the latter. So that the correct recognition of chromosome length by the usual microscopic observation or by the projection method of the writer (Kagawa, 1927, 1929, a) can be made much more easily in treated root-tips than in normal ones. It was also reported in the writer's work (1929, a) that the shortening and the thickening of chromosomes take place almost evenly in different ones in one and the same cell and in different parts of each chromosome, keeping the size relationships about the same as in those of normal roots. Besides, in treated root-tips their constrictions appear much more clearly than in ordinary ones, so that the classification and identification of chromosomes can be made more easily in the former than in the latter. In the present study the comparison of the size and shape of chromosomes was made, taking profit of their special nature just stated.

## Material and Methods

The material used in the present study is as follows:

| Species | Agronomic Varieties |
|---|---|
| *Triticum durum* Desf. | Komaba, No. 1 |
| ,,      *Spelta* L. | Ordinaire blanc sans barbes. |
| ,,      *compactum* Host. | Komaba, No. 1 |
| *Aegilops ovata* L. | |
| *Hordeum distichon* L. | Nue grosse |
| ,,      *jubatum* L. | |

In all species except *H. jubatum* the kernels were placed on wet filter-paper, and when the root-tips appeared they were immersed in 0.5 % aqueous solution of chloral hydrate for one hour. This was followed by washing in running water for the same length of time. They were placed again on the wet filter-paper, and fixed after about three hours with Benda's solution without acetic acid. As the kernels of *H. jubatum* are very small it was difficult to employ the above stated method for obtaining root-tips. So the plants were first grown in pots and when they began to head the soil of the pots was carefully washed away by water and the roots were immersed in 0.5 % solution of chloral hydrate for one hour. Then they were placed in water which was changed frequently, and after about four hours their tips were fixed with the above stated fixative.

All materials were imbedded in paraffin, cut 16–17 $\mu$ thick and stained with HEIDENHAIN's iron-alum-haematoxylin. As in other species of *Triticum* and *Aegilops* in my former work, the chromosomes in all species here appeared, owing to the effect of the treatment, as the bands or rods which are much shorter and thicker than those in normal roots. Besides, not only is the degree of their foreshortening usually much lessened by this treatment but also their constrictions are made much more clearly observable.

In each species the measurement of the longest and the shortest chromosomes in one set and the calculation of the length ratio between them were undertaken in order to get a basis for the comparison of the chromosome sets in different species of a genus. I have selected out at first, by the usual microscopic observation and by paying special attention to the foreshortening of chromosomes, some ones which seemed to be longest and shortest or nearly so. Then their lengths were measured by the projection method employed in the writer's former works (1927, 1929, a), and the longest and the shortest ones were determined, their ratios being then calculated.

In all species except *H. distichon*, it was not very easy to obtain in treated root-tips any complete set in which all chromosomes were under the state of foreshortening favourable for observation and clearly traceable along their whole length, as their number is large, especially in *T. Spelta* and *T. compactum*. In *T. durum*, *A. ovata* and *H. distichon*, the selection of the chromosomes to be measured was made on a certain number of complete sets composed of clearly traceable ones. In *T. compactum* and *H. jubatum*, not only such chromosome sets but also those showing a few which were not clearly traceable owing to their compact arrangement, or those slightly cut and contained in succeeding two sections though all or most were traceable, were employed for this purpose, while in *T. Spelta* only the two kinds lastly stated could be used.

Thus in each cell all chromosomes were not measured by the projection method, and only those which were selected in the ways as stated above were measured. The possibility that the chromosomes which are truly longest and shortest in a complete set might not have been measured is thus not entirely excluded. But, as the works of the writer (1927, 1929, a) have made possible to estimate the approximate length of chromosomes under foreshortening, it may be regarded certain that the longest and the shortest ones in the strict sense or at least those which are not much different from them were contained

among some chromosomes which were measured in each cell. Consequently, the actual ratio calculated may probably correspond either to that between chromosomes which are longest and shortest in a cell in their strict sense or at least to that not much different from such.

The preparations of treated root-tips of *Triticum polonicum, T. dicoccum, T. vulgare* and *Aegilops speltoides*, on which a report was made in the writer's previous paper (1929, a), were examined again, and the comparison of the size and shape of chromosomes between these and the species of *Triticum* and *Aegilops* in the present study was performed.

## Results of Observation

## I.   *Triticum durum, T. Spelta* and *T. compactum*

*T. durum* is a tetraploid species, where 28 chromosomes were counted in treated root-tip cells. *T. Spelta* and *T. compactum* are hexaploid species, and their somatic chromosome number was counted to be 42 in the writer's former (1927) as well as present studies.

### a.   Length of Chromosomes

The lengths of the longest and the shortest chromosomes which were measured in the above stated manner and their ratios in these three species are shown in Table I.   In this Table the length ratio between the longest and the shortest ones in cells of ordinary and treated root-tips in *T. monococcum*, a diploid species, which was reported in my former works (1927, 1929, a) is added for the sake of comparison.

The black lines in the Table represent the lengths of chromosomes. These lines are drawn on the scale 1 m.m.$=0.19\,\mu$ in order to represent the length of the chromosome considered to be shortest in cells of *T. durum* in about the same size as that of its chromosome type *c* shown in Fig. 1 and described later, because the latter type seems to be approximately the shortest one in a chromosome set in this species (refer p. 370).   The length of chromosomes in other species is also represented on the same scale as for *T. durum* for comparison.

## Table I

The lengths of the longest and the shortest chromosomes measured in cells in treated root-tips and the ratios between them in *T. durum*, *T. Spelta* and *T. compactum*.

| Species | No. of cell | Length Unit = 0.29μ. | | Ratio | |
|---------|------|---------|---------|----------|-------------------------------|
| | | Long-est | Short-est | Relative length | Diagrammatic representation |
| *T. durum* | 1 | 25.1 | 12.6 | 100:50 | |
| | 2 | 23.0 | 11.7 | 100:51 | |
| | 3 | 25.0 | 13.4 | 100:54 | |
| *T. Spelta* | 1 | (17.9) | 8.9 | (100:50) | |
| | 2 | 22.8 | 11.3 | 100:50 | |
| | 3 | 19.5 | 10.4 | 100:53 | |
| | 4 | 19.7 | 11.2 | 100:57 | |
| | 5 | 22.7 | 13.0 | 100:57 | |
| *T. compactum* | 1 | 27.6 | 14.1 | 100:51 | |
| | 2 | 19.3 | 10.0 | 100:52 | |
| | 3 | 31.0 | 16.6 | 100:54 | |
| | 4 | 23.5 | 12.6 | 100:54 | |
| | 5 | 17.0 | 9.2 | 100:54 | |
| Mean of ratios between lengths of the longest and the shortest chromosomes in ordinary and treated root-tip cells of *T. monococcum* | | | | ca. 100:68 | [1] |

In Table I the absolute length of chromosomes in each species which are longest and shortest or nearly so shows the considerable

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(1) In the diagrammatic representation in *T. monococcum* the mean of the absolute lengths of the longest chromosomes in treated root-tip cells reported by Kagawa (1929, a) is drawn on the paper on the same scale as for *T. durum*, and the line which measures 68 % of the latter shows the length of the shortest chromosome.

difference among the corresponding ones in different cells. This may be due to the fact that the size of the cell or nucleus, their nutritive conditions, the effect of treatment by chloral hydrate, etc. are not the same in different cells. The same can be said for the chromosome size of a species of *Aegilops* and two species of *Hordeum* which will be described later.

In this Table we see that the length ratios shown in different cells in *T. durum* do not present a large difference. This may perhaps be due to the fact that the chromosomes which are truly longest and shortest in each set or those very nearly so were measured. As, on the contrary, in other species the chromosome number is larger, it is more difficult to select out with much certainty the longest and the shortest ones in a set, hence the discordance just enunciated.

In *T. Spelta* cells No. 2 and 3 show the ratios which are not much different from each other, while in cells No. 4 and 5 they are somewhat smaller than in cell No. 2. This must be due to the fact that the measurements were made on the different combinations of chromosome categories. In cell No. 1 the chromosome which is indicated in parentheses to be longest was ascertained actually not to be such, because the existence of chromosomes which are slightly longer than that was proven. The former one was however measured, since it was found in a more favourable condition for observation than the longer one regarding the foreshortening. Consequently it must be said that in this species there are certain chromosomes which show among them the length ratio which is slightly larger than those presented in the above Table. In *T. compactum* also the possibility is not excluded that there may be certain chromosomes in which the larger ratio in length is to be found just as in *T. Spelta*.

In the writer's former works (1927, 1929, a), the length ratio between the longest and the shortest chromosomes in one set in *T. monococcum* was calculated to be ca. 100:68 on the basis of the results of measurement made by the projection method in root-tip cells, either normal or treated by chloral hydrate. The comparison of this ratio with the above stated ones in *T. durum*, *T. Spelta* and *T. compactum* shows the great differences between them. Accordingly, the conclusion is unavoidable that the chromosome set in *T. durum*, *T. Spelta* and *T. compactum* is not the reduplication of that of *T. monococcum*, though the respective chromosome number in the former three species corresponds either to the double or triple of that in the latter.

In *T. durum*, I have also ascertained by means of the usual obser-

vation on a number of chromosome sets showing the favourable state of foreshortening for observation, that the number of the shortest ones in each set is always two. This means that the chromosomes of *T. durum* do not also present the reduplication of a basic chromosome set of any diploid species other than *T. monococcum*. If this species were derived from the reduplication of a set of any single diploid species, we ought to find four shortest chromosomes in a somatic cell, which is not actually the case.

### b. Shape of Chromosomes

The writer (1929, a) reported that the 14 chromosomes in treated root-tip cells of *T. monococcum* may be classified into 5 types, according to the length and the number and position of constrictions therein. Though in *T. durum*, *T. Spelta* and *T. compactum* this classification is not yet made thoroughly, it was yet shown that certain chromosome types which are not contained in *T. monococcum* are observable in these three species. These types are shown in Fig. 1.
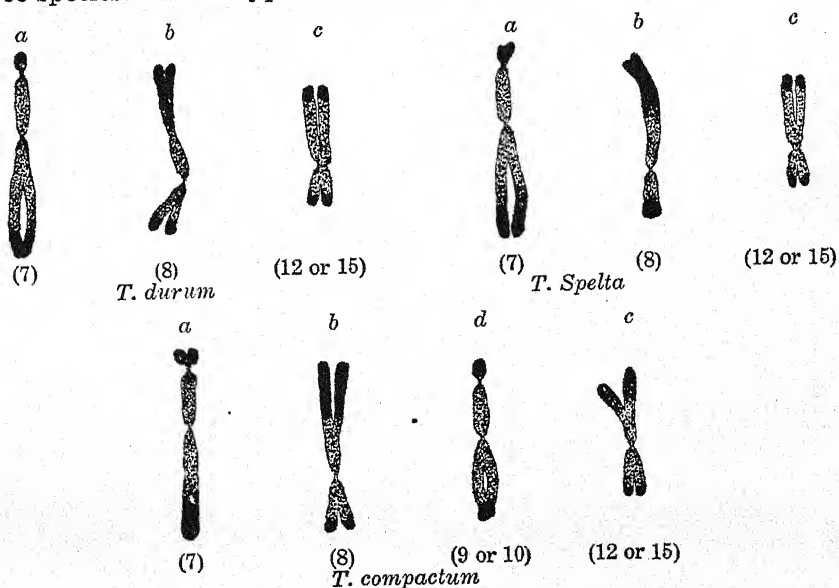
Fig. 1. Some chromosome types of the tetraploid and hexaploid species of *Triticum* which are not contained in *T. monococcum*. ×4450.[1]

(1) The chromosomes are drawn with the aid of ABBE's camera, using ZEISS apochromatic objective 1.5 m.m. and compensation ocular 18, on the plane of table, and they are reproduced here in the original size.

The chromosomes of each species in this Fig. were drawn from different cells which show about the same feature regarding the absolute length and the degree of shortening and thickening of chromosomes. In the Fig. the dotted portion of chromosomes does not contain the foreshortening, while the black portion does, though its degree is not conspicuous. In each species the chromosomes *a* and *b* show no considerable length difference between them, and they are the intermediate ones as to length of each set, while the chromosome *c* approaches in this respect the shortest one of the set. The chromosome *d* in *T. compactum* is intermediate in length between *a*, *b* and *c*. Two constrictions are placed on the chromosomes *a* and *d* in the way quite different from that in *T. monococcum*. In the chromosomes *b* and *c* one constriction is located near their respective end, which is a feature not seen in those of *T. monococcum* having one constriction. Thus, judging from the shape of chromosomes, the chromosome set of *T. durum*, *T. Spelta* and *T. compactum* may also be said not to be composed of the reduplication of the chromosome set similar to that of *T. monococcum*.

### c.    Comparison of Chromosome Types

The above stated chromosome types of *T. durum*, *T. Spelta* and *T. compactum* will now be compared to those observed by the writer (1929, a) in the two tetraploid species, *T. polonicum* and *T. dicoccum*, and a hexaploid species, *T. vulgare*. I have distinguished the chromosomes according to their length as well as the number and position of constrictions into at least 8 types in *T. polonicum*, 10 types in *T. dicoccum* and 9 types in *T. vulgare*. Some of these types were observed to be contained in common in these species and *T. monococcum*, while some others were found in all or certain species of *T. polonicum*, *T. dicoccum* and *T. vulgare*. The breadth of chromosomes does not show sensible difference among these as well as the three *Triticum* species reported in the present paper.

As is stated above, the absolute length of chromosomes of *T. durum*, *T. Spelta* and *T. compactum* differs in different cells, and there are their certain length differences in each set. I (1929, a) have observed the analogous fact in *T. polonicum*. *T. dicoccum* and *T. vulgare*. To compare the absolute length of chromosomes in different species in view of such facts, a series of chromosome sets which were entirely or nearly complete, showing differences in the absolute length

of chromosomes and also in the degree of shortening and thickening was taken in periblem in each species, and such series from different species were compared with each other. By these comparisons it was found that the absolute length of chromosomes is about the same in three tetraploid species, viz., *T. durum*, *T. polonicum* and *T. dicoccum*. If we compare these tetraploid and three hexaploid species, *T. Spelta*, *T. compactum* and *T. vulgare* to each other, it seems that the chromosomes of the hexaploid species are slightly smaller than those of the tetraploid. This may be due chiefly to the fact that in hexaploid species the increase of the size of the cell and nucleus and their nutrition, etc. is not proportionally accompanied by that of the chromosome number. So that if the chromosomes of the same kind are contained both in the tetraploid and hexaploid species, the absolute size of these chromosomes may possibly be somewhat smaller in the latter than in the former.

As can be seen in my former work (1929, a) the length ratios between chromosomes which are longest and shortest in a set either strictly or approximately are 100:52–54 in *T. polonicum*, 100:50–52 in *T. dicoccum* and 100:44–50 in *T. vulgare*. And these ratios can not be said to differ considerably from those stated above concerning *T. durum*, *T. Spelta* and *T. compactum*.

In each of these species, if a certain chromosome presents the same relative length to other ones in a cell, and the state of constriction thereon is similar in different species, it will not be impossible to consider that this chromosome in each species belongs to the same category and is contained in common in different species. The relative length of chromosomes *a* and *b* in a cell of *T. durum*, *T. Spelta* and *T. compactum* and the state of their constriction are not greatly different from those in the types No. 7 and 8 in the writer's former work in *T. polonicum*, *T. dicoccum* and *T. vulgare*. The chromosome *c* in *T. durum*, *T. Spelta* and *T. compactum* resembles the type No. 12 or 15 observed in *T. dicoccum* or *T. vulgare*, while *d* in *T. compactum* seems to be similar to the type No. 9 or 10 observed in all or certain of the three tetraploid and hexaploid species in my former work. Thus they may possibly be analogous and be contained in common in these different species. In the Fig. the number of chromosome types thus classified is shown between the parentheses.

The above stated chromosome types *a*, *b*, *c*, and *d* are comparatively easily discriminated on account of their size and shape, so that in the present study in which so much labour and time were not

devoted towards the classification and identification of chromosomes as in my former work (1929, a), we came to the result that three chromosome types which are the same were selected out in different species besides another type.

## II.  *Aegilops ovata*

*A. ovata* is a tetraploid species whose chromosome number was counted as 28 in diploid (KAGAWA, 1927).   The lengths of the chromosomes measured to be longest and shortest in a set and their ratios can be seen in Table II.    In this Table the length ratio[1] between the chromosomes which are longest and shortest or nearly so in treated root-tip cells of *A. speltoides*, a diploid species, is added for comparison's sake.

### TABLE   II

The lengths of the longest and the shortest chromosomes measured in cells in treated root-tips of *A. ovata* and the ratios between them.

| No. of cell | Length Unit÷0.29 μ | | Ratio | |
|---|---|---|---|---|
| | Longest | Shortest | Relative length | Diagrammatic representation |
| 1 | 25.7 | 13.1 | 100:51 | |
| 2 | 29.4 | 15.1 | 100:51 | |
| 3 | 20.7 | 11.2 | 100:54 | |
| 4 | 22.0 | 12.0 | 100:55 | |
| Mean of the ratios of lengths between chromosomes which are longest and shortest or nearly so in treated root-tip cells of *A. speltoides*. | | | ca.  100:65 | (2) |

(1)  The results obtained by KAGAWA (1929, a).

(2)  In the diagrammatic representation in *A. speltoides* the mean values of the absolute lengths of the chromosomes which are longest and shortest or nearly so in different cells in treated root-tips are drawn on the same scale as was used for the chromosomes of *A. ovata*.

The ratios shown by cells No. 1–4 do not differ greatly from each other. I (1929, a) have measured by means of the projection method the lengths of the chromosomes which were longest and shortest or nearly so in a set in treated root-tips of *A. speltoides* (2n=14), and found that the length ratio between them was ca. 100:65. The results obtained in *A. ovata* show great difference against this ratio, and consequently it is certain that the chromosome set of *A. ovata*, a tetraploid species, does not represent the reduplication of a chromosome set similar to that of *A. speltoides*, a diploid species.

I (1929, a) have observed that each of the 14 chromosomes in treated root-tip cells of *A. speltoides* shows a constriction at the middle part or more or less apart from it, and that this constriction coincides with the point of insertion of the spindle fibre. I (1927) have observed in normal root-tip cells of *A. ovata* that certain chromosomes are attached to the spindle fibre at a point quite near their end. In the present study it was observed that certain metaphasic chromosomes in treated root-tip cells of this species present a constriction which was located at a point quite near the chromosome end, which is the feature not seen in *A. speltoides*. In some anaphasic side views, the chromosomes of probably the above stated kind were observed to be inserted to the spindle fibre at the point corresponding to that of the constriction and the latter could not be actually observed, it being probably found just at the apex of V whose two arms differ greatly in length. In some cells I could observe at least two types of such chromosomes. Those shown in Fig. 2 are drawn from a single cell and show two types of this kind. In *a* the amount of foreshortening is small, while in *b* it is rather considerable, especially in the upper part of the Fig. It is therefore quite certain that *b* is actually considerably longer than *a*, though they appear to be about of the same length in their



Fig. 2. Two types of chromosomes in a treated root tip cell of *A. ovata*, showing one constriction at a point quite near their end. × 4450.

respective planes presented in the Fig. The thorough classification and identification of chromosomes in *A. ovata* according to their shape are not yet made, but the fact stated above may be one of the reasons to conclude that the chromosome set of *A. ovata* does not present the reduplication of that of *A. speltoides*.

## III. *Hordeum distichon* and *H. jubatum*

The number of chromosomes in *H. distichon* was counted to be 14 and that in *H. jubatum* 28, both in treated root-tips. This number in *H. jubatum* corresponds to its haploid number reported by AASE and POWE S (1926), so that this species is tetraploid. The length difference among chromosomes in a set of *H. distichon* is not large, and it was somewhat difficult to select out by the usual observation the longest and the shortest ones with certainty. So at least 6 chromosomes were selected out in each cell to be measured by the projection method. In *H. distichon* they present 1–3 clear constrictions. The results of the measurements in two species are given in Table III.

TABLE III

The lengths of the longest and the shortest chromosomes measured in cells in treated root-tips and the ratios between them in *H. distichon* and *H. jubatum*.

| Species | No. of cell | Length Unit ≐ 0.29 μ | | Ratio | |
| | | Longest | Shortest | Relative length | Diagramatic representation |
|---|---|---|---|---|---|
| *H. distichon* | 1 | 27.5 | 18.4 | 100:67 | |
| | 2 | 29.0 | 20.0 | 100:69 | |
| | 3 | 25.7 | 17.7 | 100:69 | |
| | 4 | 25.5 | 18.0 | 100:71 | |
| *H. jubatum* | 1 | 22.7 | 13.6 | 100:60 | |
| | 2 | 25.3 | 15.2 | 100:60 | |
| | 3 | 23.7 | 14.9 | 100:63 | |
| | 4 | 27.1 | 17.1 | 100:63 | |
| | 5 | 21.0 | 13.4 | 100:64 | |

The ratios shown in different cells in each species can not be said to present a large difference among each other. When we compare these two species as a whole to each other, we do not find such large differences as in diploid and tetraploid species of *Triticum* and *Aegilops*.

The difference of ratios is however somewhat clear between these two species of *Hordeum*, so that it may be said that the chromosome set of tetraploid *H. jubatum* is not the reduplication of a set morphologically similar to that of diploid *H. distichon*.

I have measured the size of pollen grains in these two species. The results obtained from 250 pollen grains in each species are shown in Table IV.

TABLE IV

The size of pollen grains in *H. distichon* and *H. jubatum*

| Species | Long axis mean in $\mu$ | Short axis mean in $\mu$ | Volume[1] mean in $\mu^3$ | Relative size | Chromosome number 2n |
|---|---|---|---|---|---|
| *H. distichon* | 51.2 | 46.5 | 57,968 | 100 | 14 |
| *H. jubatum* | 41.8 | 40.4 | 35,723 | 62 | 28 |

If in a tetraploid species the reduplication of the chromosome set similar to that of a diploid species had taken place the increase of the cell volume would follow necessarily. But as can be seen in this Table the size of pollen grains in *H. jubatum* is smaller than that of *H. distichon*, and this may stand parallel to the results of the chromosome measurement stated above.

In *Triticum* and *Aegilops* it was possible to ascertain without employing the projection method that the length ratios of the longest and the shortest chromosomes either strictly or approximately are far larger in a cell of the tetraploid or hexaploid than in the diploid species. The same can be said in making clear that the ratios observed in *H. jubatum* do not show a large but rather clear difference towards those found in *T. distichon*. But in all these cases the foreshortening of more or less extent is almost always present in every chromosome, so that it is not possible to estimate the precise length ratios without employing the projection method. And in studying the chromosomes of related species above stated in view of their phylogeny, some conclusions could be drawn only through the consideration of the precise length ratios obtained by the projection method.

(1) Calculated as the volume of an ellipsoid.

## Discussion

Though for elucidating the phylogenetic relationships of related species there may be a number of methods, the precise comparison of their chromosomes according to their size and shape may afford us a clue for this purpose.

KIHARA and ONO (1926) distinguished two categories of polyploidy according to the composition of the chromosome set, viz. auto- and allopolyploidy. The works of recent investigators have shown many examples which may be regarded as autopolyploidy. The examples where the latter case was brought to light by the mode of chromosome pairing, were reported by ONO (1927) in *Primula*, by CLAUSEN (1927) in *Viola*, by HUBER (1927) in *Veronica*, by KAZAO (1928) in *Iris* and by DARLINGTON (1928) in *Prunus*. KAZAO states that *Iris gracilipes* (n= 18) may possibly be the basic diploid species from which triploid *I. japonica* (2n=54) might be derived, and CLAUSEN reports that the basic diploid species for *Viola elatior* (n=20) may be *V. stagnina* (n=10).

On the basis of the study of the size and shape of somatic chromosomes M. NAWASCHIN (1927) concludes that the triploid (2n=9) and pentaploid (2n = 15) forms of diploid *Crepis capillaris* (2n = 6) and further the triploid (2n = 12) and tetraploid (2n=16) forms of diploid *C. tectorum* (2n=8) contain the reduplicated haploid sets of the respective diploid species. DELAUNAY (1927) reports on the basis of similar studies that the chromosome sets of diploid, tetraploid and pentaploid species of *Muscari* are composed of 2-, 4- and 5-fold reduplication of a basic chromosome set, and he also reports that the chromosome sets of diploid and tetraploid species of *Bellevalia* present 2- and 4-fold reduplication of a basic set.

JARETZKY (1928) seems to consider, from the comparison of the size between meiotic chromosomes and that of pollen mother-cells as well as their nuclei, that the chromosome sets of *Arabis pumila* (n=8) and *Alyssum corymbosum* (n=8) are or may possibly be contained in duplicated state in *Arabis hirsuta* (n=16) and *Alyssum calycinum* (n=16) respectively. DARLINGTON (1928) classified the special types of chromosomes in *Prunus* according to their size and shape, and reported that the number of similar chromosomes contained in somatic cells of diploid species is 2, of triploid one 3 and so on. All above cited cases may belong to the autopolyploidy.

HURST (1928) distinguishes in *Rosa*, on the basis of the cytological, taxonomical and genetical studies, a certain number of septets, each of which contains 7 chromosomes, and he reports that a number of species, subspecies and varieties showing auto- or allopolyploid nature regarding these septets are present in this genus.    JØRGENSEN (1928) obtained tetraploid shoots derived from the special cutting method employed on each of diploid *Solanum Lycopersicum* (n=12) and diploid *S. nigrum* (n=36).    He also obtained in the same way the plants having duplicated number of chromosomes from $F_1$ between two varieties of *S. Lycopersicum* and from $F_1$ of *S. nigrum* × *S. luteum* (n=24).   He thinks that these shoots or plants having tetraploid or duplicated number of chromosomes might have been derived from tetraploid or binucleate cells in the somatic tissue of the plants, from which these aberrants were produced.    In these cases the auto- or allopolyploidy would have been resulted according to the composition of the chromosome sets of the original plants.    He has obtained by the parthenocarpy which occurred when diploid *S. nigrum* was pollinated by the pollen grains of other *Solanum* species, haploid *S. nigrum* in which 36 chromosomes were counted in somatic cells.    He observed in the meiosis of this plant the chromosome behaviour characteristic of triploid plants and also the appearance of trivalent chromosomes, and accordingly he assumed that the usual diploid *S. nigrum* might have possibly been produced by the reduplication of chromosomes in triploid plants derived from a species having 12 chromosomes in haploid.   If this is true it can be said that the autopolyploidy is present here also.

DELAUNAY (1927) made the classification and the comparison of chromosomes in some species of *Muscari*, *Bellevalia* and *Ornithogalum*, and found that certain chromosome types were contained in common in different species in a genus, but that the length of the corresponding chromosomes was not the same in different species.   He considered that this may be due to the fact that the decrease of the chromosome length has occurred during the course of the phylogenetic development of species.    M. NAWASCHIN (1927) states in the chromosome studies in some *Crepis* species that the chromosomes may change their size and shape during the phylogeny of species.   The same author (1928) reports in the study on the morphology of chromosomes in species hybrids of *Crepis* that certain chromosomes may change their morphological characters as the results of hybridization.

In the following lines the discussions will be made on the phylogenetic relationships among different species in each genus described in

the present paper under the assumption that the individuality of chromosomes was not altered during their phylogenetic development.

In my former work (1929, a) I have reported, under the consideration of the size and shape of somatic chromosomes that *T. polonicum* and *T. dicoccum*, both of which are tetraploid, and *T. vulgare*, which is hexaploid, are not the autopolyploid species formed by the reduplication of a set which was morphologically similar to that of diploid *T. monococcum*. The same conclusions were also drawn in the present study for tetraploid *T. durum* and for hexaploid *T. Spelta* and *compactum*. The fact that *T. polonicum* and *T. durum* are not autotetraploid species derived from a chromosome set of any diploid species other than *T. monococcum* was elucidated in my former as well as present studies. I have drawn the analogous conclusions for *T. dicoccum* and *T. vulgare* on account of the number of homologous chromosomes observed in a somatic cell. But in the present study sufficient observation to make such determination in *T. compactum* and *T. Spelta* is not yet made. But GAINES and AASE (1926) observed in the meiosis of a haploid plant derived from *T. compactum* that usually 21 univalent chromosomes appeared and only occasionally the mating of a small number of chromosomes took place. MELBURN and THOMPSON (1927) reported that 0–5 bivalent and 28–18 univalent chromosomes were formed in the $F_1$ meiosis of *T. Spelta* × *T. monococcum*. Considering these facts it can be said that *T. Spelta* and *T. compactum* are not the autohexaploid species derived from a single basic diploid one.

Thus *Triticum* species can not be said to have been formed by any possible phylogenetic causes which involved the reduplication of a basic chromosome set, but they may have been produced by the crosses among ancestral forms having different chromosome content. I (1929, a) have reported that certain chromosome types, classified by their size and shape, were contained in common in all or certain species of *T. monococcum*, *T. polonicum*, *T. dicoccum* and *T. vulgare*. And in the present study it was found to be possible that some of these chromosome types are also contained in *T. durum*, *T. Spelta* and *T. compactum*. Considering these facts it seems that all or some of the *Triticum* species might possibly have as their ancestral forms the similar plant forms in common.

I (1929, a) have reported that *Aegilops cylindrica* is not an autotetraploid species derived from a chromosome set which was morphologically similar to that of diploid *A. speltoides*. In the present study the same conclusion was made for *A. ovata*. But whether or not

$A.$ _ovata_ is an autotetraploid species derived from a diploid one other than $A.$ _speltoides_ was not decidedly concluded by the comparison of the size and shape of chromosomes. But I (1929, b) have observed in $F_1$ meiosis of $A.$ _ovata_ × $T.$ _polonicum_ that usually 28 univalent chromosomes appeared at the first division, though in some cases the longitudinal connection of two chromosomes was seen. According to PERCIVAL (1926), KIHARA (1928) and BLEIER (1928) there appear in the meiosis of $F_1$-s between $A.$ _ovata_ and di-, tetra- or hexaploid species of _Triticum_ so many univalent chromosomes as they correspond to the sum of the haploid numbers of the parents, and in some cases certain chromosomes form bivalents, whose compactness is in many cases reported to be loose. Taking these facts into account it seems that $A.$ _ovata_ is not the autotetraploid species derived from a diploid one other than $A.$ _speltoides_.

I (1927) have reported that the length ratios between certain chromosomes in a cell in normal root-tips of $A.$ _squarrosa_, which has 14 chromosomes in haploid (KAGAWA, 1928), are considerably larger than that between the longest and the shortest chromosomes in a set of $T.$ _monococcum_, which is ca. 100:68. And the length ratio of chromosomes which are longest and shortest or nearly so in a set of $A.$ _speltoides_ is ca. 100:65. Thus there is in this respect no large difference between $T.$ _monococcum_ and $A.$ _speltoides_. Considering this together with the above stated facts, it seems that $A.$ _squarrosa_ is probably not an autotetraploid species derived from the reduplication of a chromosome set morphologically similar to that of $A.$ _speltoides_, though the precise chromosome measuring is not yet made in $A.$ _squarrosa_.

When we compare _Hordeum distichon_ and _H. jubatum_ to each other, the former, which is diploid is considerably larger in height, stem diameter, length and breadth of leaves, spikes and spikelets and other external characters than the latter, which is tetraploid, though not autopolyploid in regard to the former species. And the size of pollen grains is also larger in the former than in the latter.

JARETZKY (1928) reports that the size of the vegetative organs of _Alyssum calycinum_ (n=16) is smaller than that of _Al. saxatile_ (n=8). The same conditions were reported by SINOTÔ (1925) in _Plantago_. According to HUBER (1927), the increase of chromosome number is accompanied by that of the size of the pollen grains in different species of _Veronica_ belonging to a single taxonomic section, while the reverse condition is found if the comparison is made among different species

belonging to different sections.   HÅKANSSON (1928) observed by compar-
ing the different species of *Scirpus* belonging to different taxonomic
groups, that the species having a larger number of chromosomes
showed smaller size of pollen mother-cells than those having less
number.   The facts stated above in two species of *Hordeum* present
an example which is analogous to the latter observation.

## Summary

1.   The size and the shape of chromosomes in three species of
*Triticum*, a species of *Aegilops* and two species of *Hordeum* were
observed in root-tips treated by the dilute solution of chloral hydrate,
and on the basis of such observations the discussions were made on
the phylogenetic relationships of related species.

2.   The length ratios between the chromosomes which are longest
and shortest in one set or those between the chromosomes not differing
much from them in different cells of treated root-tips are 100:50–54 in
*T. durum*, a tetraploid species, 100:50–57 in *T. Spelta* and 100:51–54
in *T. compactum*, both of which are hexaploid.

3.   These ratios show large differences compared to the ratio ca.
100:68 which was found by the writer (1927, 1929, a) between the
longest and the shortest chromosomes in cells in normal and treated
root-tips of diploid *T. monococcum*.

4.   Judging by the size and shape of chromosomes it is found that
the chromosome set of *T. durum*, *T. Spelta* and *T. compactum* contains
some chromosome types which were not observed in the writer's
works (1927, 1929, a) in the chromosome set of *T. monococcum*.

5.   Thus the chromosome set of *T. durum*, *T. Spelta* and *T. com-
pactum* does not present, considering the size and shape of chromo-
somes, the reduplication of that of *T. monococcum*, though the
chromosome numbers of the former three species are certain multiples
of that of *T. monococcum*.

6.   Accordingly, these three tetraploid and hexaploid species
might not have been phylogenetically formed by any possible causes
which involved the reduplication of a chromosome set morphologically
similar to that of *T. monococcum*.

7.   In a chromosome set of *T. durum* only two shortest chromo-
somes are observed.   Consequently, this species might not also have
been phylogenetically formed by the reduplication of a chromosome
set of any diploid species other than *T. monococcum*.

8.   Some chromosome types characterized by their size and state of constriction are contained in common in *T. durum*, *T. Spelta* and *T. compactum*.   Some chromosomes, including these, seem to be similar to those which were observed by the writer (1929, a) in all or certain species of *T. polonicum*, *T. dicoccum*, and *T. vulgare*.

9.   *T. durum*, *T. Spelta* and *T. compactum* may probably have been phylogenetically derived from the crosses which occurred among certain ancestral forms having different chromosome content.   And it seems that all or some of these species and the above stated three tetraploid and hexaploid species in the writer's former work have certain ancestral forms in common.

10.   The length ratios between the chromosomes which are longest and shortest or near to them in different cells in treated root-tips of tetraploid *A. ovata* are 100:51–55.

11.   These ratios present large differences compared to the ratio ca. 100:65 which was calculated as such by the writer (1929, a) in cells of treated root-tips of *A. speltoides*, a diploid species.

12.   The length ratios between the chromosomes which are longest and shortest or near to them in different cells in treated root-tips of *H. distichon*, a diploid species, are 100:67–71, and those of *H. jubatum*, a tetraploid species, are 100:60–64.   Thus it can be said that there is somewhat clear difference between the ratios of the two species.

13.   Accordingly, *A. ovata* and *H. jubatum* are not the autotetraploid species derived from the reduplication of a chromosome set morphologically similar to that of *A. speltoides* or *H. distichon* respectively.   In *Hordeum* this conclusion was also drawn by the comparison of the size of pollen grains of both species.

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# Zur Kenntnis der Befruchtung und Kornbildung bei den Reispflanzen[1]

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Im Gebiete der Pflanzenzüchtung ist die genaue Kenntnis der Befruchtung und Kornbildung bei jeder Kulturpflanze eine unbedingte Erfordernis. Leider hat man aber bisher nur wenige derartige Arbeiten betreffend die Reispflanzen gehabt.

KUWADA[2] hat die Entwicklung des Endosperms beim Reis zytologisch studiert. Auch fand AKEMINE[3] die Tatsache, dass unter günstigen Aussenbedingungen die Befruchtung etwa 12 Stunden nach dem Aufblühen beginnt und nach etwa einem Tage vollständig zum Ende kommt, wonach der Ausbildungsvorgang des Embryos und des Endosperms sogleich eintreten wird.

Es schien mir wünschenswert zu sein, eine eingehende Studie über das in Rede stehende Thema auszuführen. Seit 1926 war ich deshalb im hiesigen Institute mit einer Untersuchung über die Befruchtung von Reis und einige daran sich anknüpfende Erscheinungen beschäftigt. Die Ergebnisse davon möchte ich in der vorliegenden Mitteilung geben. Nachdem meine Arbeit zum Ende gekommen ist, erschien dieselbe von TERADA[4] über das gleiche Thema.

## Material und Methode

Als Versuchsmaterial dienten mir die reinen Linien der Reissorten „Aikoku" und „Schinriki", die seit langer Zeit im Garten unserer Fakultät kultiviert wurden. Um die Tatsache genau kennen zu

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(1) Diese Arbeit wurde teilweise im der am 6. Mai 1928 in Morioka gehaltenen Versammlung der Japanischen Gesellschaft der wiss. Landw. veröffentlicht.
(2) Bot. Mag. Tokyo **24** (1910), 267.
(3) Zeitschr. f. Pflanzenzüchtung **2** (1914), 339.
(4) Journ. Coll. Agr. Hokkaido Imp. Univ. **19** (1928), 245.
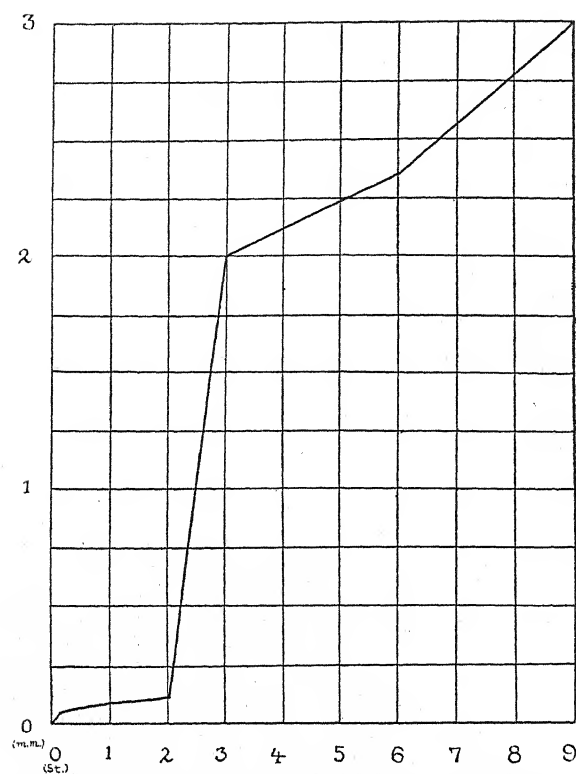
Fig. 4.  Die Geschwindigkeit des Pollenschlauchlängenwachstums;
Ordinate = Länge des Pollenschlauches, Abszisse = Stunden
nach der Pollenkeimung.

Der Pollenschlauch dringt in den Interzellarraum der Narbe, un-
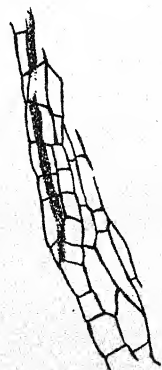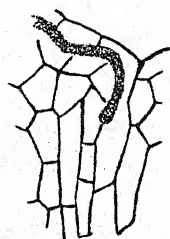


Fig.  5.                                          Fig.  6.

Fig. 5-6.  Die Pollenschläuche in der Narbe.  (× 450)

mittelbar unter der Epidermis, ein (Fig. 5 und 6)[1] und gelangt nach etwa 2 Stunden zur Basis von Narben, wobei er zwischen den klein-
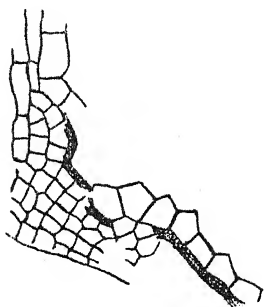


Fig.  7.

Fig. 7.  In der Fruchtknotenwand eindringende
Pollenschläuche.  (× 450)

und grosszelligen Parenchymen läuft und in der Fruchtknotenwand eintritt (Fig. 7).   Zwei besondere Zellschichten kann man auf der
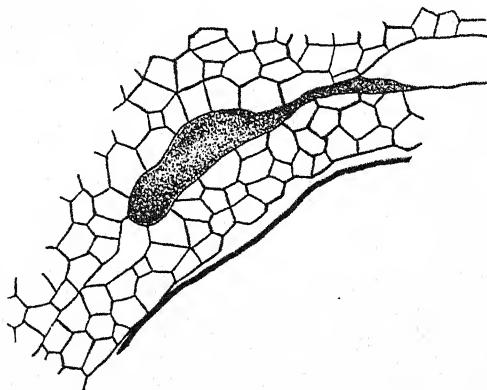


Fig.  8.

Fig. 8.  Die Pollenschläuche in der Frucht-
knotenwand.  (× 850)

Innerseite der Fruchtknotenwand sehen.   Nach sechs Stunden befinden sich die Pollenschläuche schon ausserhalb dieser Zellschichte (Fig. 8).[2]

---

(1)  MILLER. (Journ. Agr. Res. **18** (1920), 253) fand bei Mais, dass der Pollenschlauch im Parenchym oder Gefässbundel der Narben verläuft.
(2)  Ich konnte einmal an der Spitze des Pollenschlauches einen leeren Raum zwischen solchen Zellenschichten und anderen Zellen der Fruchtknotenwand sehen, aber es ist unentscheiden, ob derselbe schon von vornherein dort gewesen war oder erst durch den Eintritt des Schlauches entstanden ist.

An meinen zahlreichen Präparaten habe ich zugleich viele Pollen-
schläuche in einem Griffel beobachten können, doch war immer nur
ein einziger in der Fruchtknotenwand nachgewiesen, wie MILLER bei
Mais gefunden hat.

Neun Stunden nach der Bestäubung gelangt der Pollenschlauch
zur Mikropyle, wo er einige Male sich krümmt und dann durch dieselbe
und das Nucellargewebe den oberen Teil des Embryosackes erreicht.[1]

Um genau die Zeit zu bestimmen, wo der Pollenschlauch in die
Eizelle eintritt, habe ich die 9–12 Stunden nach der Bestäubung fixier-
ten Fruchtknoten studiert, aber ich konnte diese Erscheinung erst an
den nach 12 Stunden fixierten erkennen.

Nach zwölf Stunden schwillt sich und zerbricht der Pollenschlauch
an seiner nahe der Eizelle gelegenen Spitze, woraus zwei Spermakerne
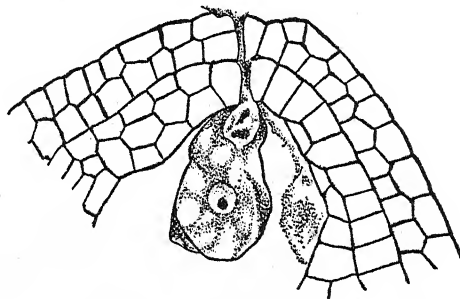


Fig.  9.

Fig. 9.   In der Eizelle eindringende Pollenschlauch-
              spitze.   (× 450)

herausgehen (Fig. 9).   AKEMINE und neuerdings TERADA haben be-
richtet, dass die Befruchtung von Reis 12 Stunden nach dem Aufblühen
erfolgt, was mit meinen Beobachtungen ganz übereinstimmt.   Die Tat-
sache, wie zwei Spermakerne im Pollenschlauche sich verhalten, konnte
gar nicht beobachtet werden, indem der Inhalt desselben sich mit dem
Farbstoffe zu stark färbt.

## Befruchtung

Schon am Anfange des Befruchtungsvorganges sind die Syner-
giden auf dem Weg der Entartung und beide Polkerne, die fast völlig

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(1)   Nach TERADA bahnt der Pollenschlauch seinen Weg zur Eizelle an die Seite
einer Synergide, aber ich selbst konnte diese Tatsache nicht finden.

miteinander verschmolzen sind (Fig. 10), nehmen ihre Stelle nahe bei
der Eizelle ein.    Unter zwei spiralförmigen Spermakernen (Fig. 11)
nähert sich der eine dem Eikerne und der andere geht in die Polkerne
über (Fig. 12).    Die männliche und weibliche Kerne in der Eizelle



Fig.  10.

Fig. 10.   Zueinander  nähernde  Pol-
           kerne.  (× 850)



Fig.  12.

Fig. 12.   Ein Spermakern nahe dem
           Eikerne  und  der  andere
           nach Polkernen  gehend.
           (× 850)



Fig.  11.

Fig. 11.   Zwei spiralförmige Sperma-
           kerne.  (×1350)

bleibe lange unvereinigt, wobei man gar keinen Unterschied zwischen
beiden finden kann.    Der zweite Spermakern fängt aber dann mit
einem Polkern zu vereinigen an, und erst nachher folgt die Vereini-
gung von zwei Polkernen (Fig. 13),[1] womit der erste Endospermkern



Fig.  13.

Fig. 13.   Dreifache Verschmel-
           zung.  (× 1350)
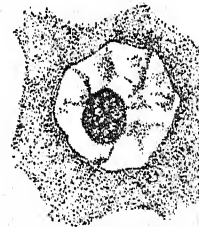


Fig.  14.

Fig. 14.   Der grosse erste Endo-
           spermkern.  (× 1350)

resultiert (Fig. 14).    Bald danach findet die Verschmelzung von zwei
Kernen in der Eizelle statt.    Das oben gesagte bestätigt das Geschehen
der Doppelbefruchtung bei den Reispflanzen, wie schon KUWADA und
TERADA berichtet haben.

---

(1)  KUWADA hat beobachtet, dass erst der zweite Spermakern mit dem oberen
Polkern vereinigt; dagegen fand ich, dass er zuerst mit dem unteren vereinigt.

# Embryoentwicklung

Während einiger Zeit, d.h. etwa 6 Stunden, bleibt der Embryokern unverändert (Fig. 15) und dann tritt der erste Kernteilungsvorgang plötzlich ein (Fig. 16 u. 17). In diesem Stadium hat TERADA[1] zwei Nucleolen in dem Kern bemerken können, aber bald kommen die elterlichen Elemente zu völliger Verschmelzung. Durch den Teilungsschritt wird die basale Zelle zu zwei übereinander liegenden Zellen geteilt,
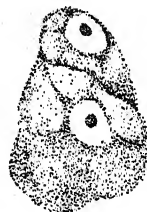
Fig. 15.        Fig. 16.        Fig. 17.
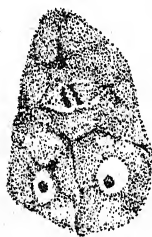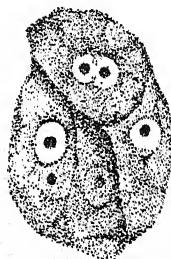
Fig. 18.        Fig. 19.

Fig. 15–19. Die Teilungsschritte der Embryozelle. (× 600)

worauf die senkrechte Teilung jeder Zelle unmitterbar folgt (Fig. 18). Derartigen Teilungstyp der Embryozelle fand TANNERT[2] bei Hafer, aber PERCIVAL[3] hat bei Weizen beobachtet, dass die grosse basale Zelle fast nie teilt und die zweite parallele Teilung nur in der oberen geschieht.[4] Auf Tab. II zeigte ich die Umfangsänderung der Embryozelle in diesem Stadium (Fig. 15–19).

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(1) l. c.
(2) Entwicklung und Bau von Blüte und Frucht von *Avena sativa*, L. Inaugural-Diss., Univ. Zürich. (1905).
(3) The Wheat Plant. (1921).
(4) Bei Gerste fand HAMADA eine ähnliche Erscheinung (noch nicht veröffentlicht).

## TABELLE  II

| Stadium | Bei der Be-stäubung | Bei der Be-fruchtung | Bei erster Kern-teilung | Bei erster Zelltei-lung | Bei zwei-ter Kern-teilung | Bei zwei-ter Zell-teilung | Bei drit-ter Kern-teilung | Bei drit-ter Zell-teilung |
|---|---|---|---|---|---|---|---|---|
| Länge (m.m.) | 0.030 | 0.031 | 0.035 | 0.045 | 0.050 | 0.050 | 0.056 | 0.054 |
| Breite (m.m.) | 0.020 | 0.020 | 0.026 | 0.041 | 0.030 | 0.040 | 0.040 | 0.046 |

Etwa 24 Stunden nach der Bestäubung kann man schon den aus 4–7 Zellen gebildeten Embryo finden, welcher bis zum folgenden Tag sich allmählich zu einem kugeligen Zellklumpen entwickelt (Fig. 20). Mit der Zeit werden die Zellteilungen allmählich lehbhafter, um
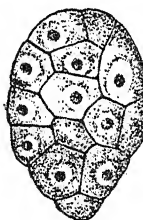


Fig.  20.
Fig. 20.    Der Embryo, 2 Tage nach dem Blühen.
(× 450)

schliesslich die eiförmige Keimanlage zu produzieren.   Nach 4 Tagen, dank dem heftigen Wachstum wird an ihrer Spitze eine Kerbe sichtbar, die das erste Zeichen der Differenzierung darstellt (Fig. 21).



Fig.  21.              Fig.  22.              Fig.  23.
Fig. 21–23.    Embryo bei 5., 7. und 10. Tage nach dem Aufblühen.
(Fig. 21 ×120, Fig. 22 ×100, Fig. 23 ×50)

Nach 7 Tagen beginnen sowohl die Anlagen der Plumula und Koleoptile sichtbar zu sein (Fig. 22), die während nachfolgenden 6 Tagen sich vollständig entwickeln werden, wogegen die Würzelchenanlage sich erst nach 10 Tagen bemerkbar machen wird (Fig. 23).

Zwei Wochen nach dem Aufblühen liegt der vollentwickelte Embryo auf der Bauchseite des Kornes, der einerseits durch das Schildchen vom Endosperm abgrenzt und anderseits durch die Samenschale bedeckt wird.

Ich habe die Grösse der wachsenden Embryonen bei verschiedenen Zeitperioden gemessen; die Ergebnisse sind in Tab. III angegeben.

TABELLE III

| Nach der Bestäubung | 18 St. | 24 St. | 48 St. | 72 St. | 96 St. | 120 St. | 168 St. | 10 Tage | 12 Tage | 15 Tage | Vollreife |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Länge (m.m.) | 0.039 | 0.051 | 0.061 | 0.129 | 0.156 | 0.230 | 0.286 | 1.471 | 1.630 | 1.743 | 1.790 |
| Breite (m.m.) | 0.025 | 0.042 | 0.044 | 0.083 | 0.103 | 0.153 | 0.147 | 0.663 | 0.760 | 0.930 | 0.890 |

## Endospermbildung

Der erste Endospermkern teilt sich, ohne sofort durch die Zellbildung gefolgt zu werden, weshalb beide Tochterkerne in der Mitte des Embryosackes nebeneinander stehen (Fig. 24). Die Vermehrung des Kerns setzt weiter fort und einige Dutzende Kerne sind schon nach 12
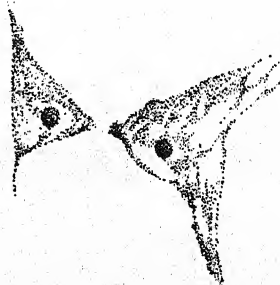


Fig. 24.
Fig. 24. Die erste Teilung des Endospermkernes.
(× 850)

Stunden produziert (Fig. 25).   Diese Kernteilungen sind ganz normal.[1]
Am 2. Tage nach dem Blühen bedeckt sich die Innerfläche des Embryo-
sacks vollständig mit Endospermkernen, die besonders um den Embryo
herum sammeln, wobei eine Menge der mit Farbstoffe leicht färbbaren
Körnchen zwischen jedem Kern auftreten (Fig. 26).   Es wird nicht
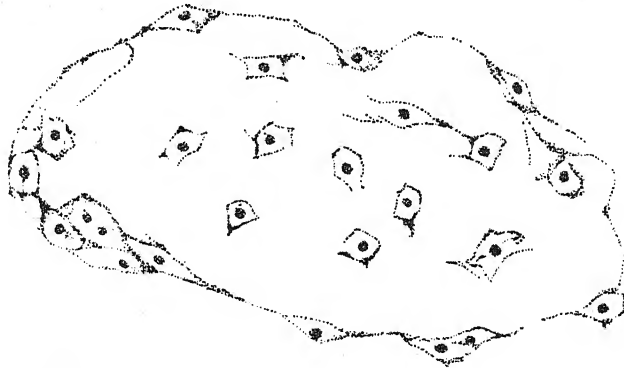


Fig.  25.



Fig.  26.
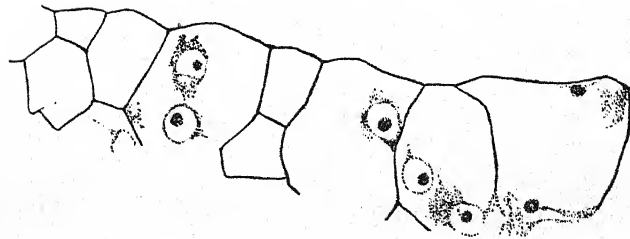


Fig.  27.

Fig. 25-27.   Die Endospermkerne auf der Innerfläche des
Embryosacks.  (× 450)

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[1]  Die eingehenden Beobachtungen über die Teilungsvorgänge der Kernele-
mente haben KUWADA und TERADA veröffentlicht (l. c.).

unmöglich sein, dass für die Bildung der Zellmembranen, die man 3–4
Tage nachher im Endosperm nachweisen kann, diese Körnchen als
Material dienen.   Nach 5 Tagen kann ich schon zwei Schichten der
Endospermzellen bemerken, wo anfangs ausser dem Kerne geringes
Zytoplasma sich befindet (Fig. 27), und danach allmählich der Zellinhalt
immer mehr zunimmt.

Binnen 10 Tagen füllen die Endospermzellen den ganzen Embryo-
sack, wo sie am Randteile besonders kompakt gelagert sind; dieselben
in der Nähe des Embryos beginnen allmählich sich zu degenerieren.
TERADA beobachtet, dass am 8.–10. Tage nach dem Aufblühen die
Kohlehydrate in den Endospermzellen anzuhäufen beginnen und am 11.
Tage die Stärkekörnchen daraus produziert werden.   Bei Gerste be-
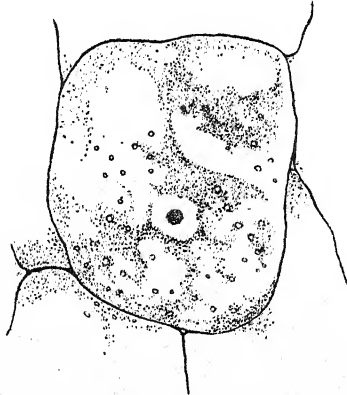
Fig.   28.
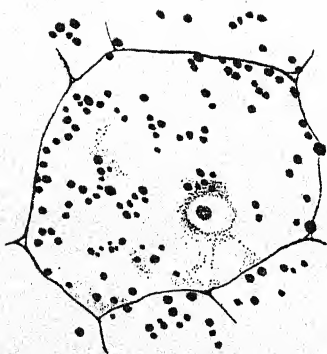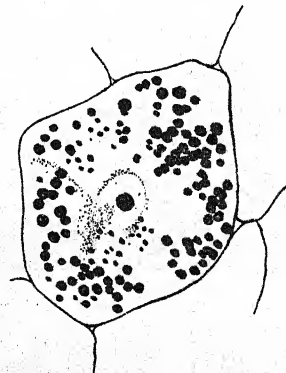
Fig.   29.                                    Fig.   30.

Fig. 28-30.   Das Auftreten von Stärke an 7., 10. und 20. Tage
nach dem Aufblühen.   (× 1350)

merkten BRENCHLEY[1] nach 6 Tagen und HARLAN[2] nach 4 Tagen die erste Stärkebildung. Auf Grunde der oben erwähnten Beobachtungen bei Gerste, erwartete ich, dass auch bei Reis das Auftreten von Stärke noch früher stattfinden mag als TERADA beobachtet hatte, sodass ich diesen Punkt besonders näher studiert habe. In einem nach 7 Tagen gesammelten Materialien fand ich zuerst die sehr kleinen Körnchen, die man nur bei sehr starker Vergrösserung nachweisen kann (Fig. 28); sie wachsen gleichmässig an und nach 10 Tagen erreichen sie die Grösse eines Zellkernes (Fig. 29). In diesem Stadium (8–10 Tage) fängt der Kern der Endospermzelle zu zerbrechen an; dieser Vorgang beginnt erst an einer gewissen Stelle nahe dem Embryo und geht zum gegenseitigen Ende hinüber.[3] Das Auftreten der Stärke beginnt neben dem Embryo und geht nach oben hin, wie BRENCHLEY bei Gerste fand. Zwischen 15.–20. Tage kann man die sekundären Stärkekörnchen nachweisen (Fig. 30).

## Synergiden und Antipodalzellen

*Synergiden:*

Vor dem Blütenöffnen sieht man schon den Eintritt der Degeneration von zwei Synergiden, welche an beiden Seiten der Eizelle sitzen. Nach einigen Stunden beginnen ihre Kerne zu verschwinden und zugleich wird der ganze Inhalt der Zelle stark verdichtet und durch Farbstoffe leicht färbbar. Immer weiter geht der Degenerationsvorgang mit der Zeit, und etwas mehr als 24 Stunden nach der Befruchtung ist kein Spur der Synergide mehr zu sehen.

*Antipodalzellen:*

MILLER fand bei Mais, dass die Antipodalzellen, wenn sie keine Artungserscheinungen zeigen, durch den entwickelnden Embryo nach der inneren Embryosackwande verdrängt werden. Bei Reis weist man dagegen die Ausartungen unmittelbar nach der Bestäubung nach.

Das Stadium, in welchem die Antipodalzellen zu entarten beginnen, wird verschiedentlich berichtet: nach KUWADA[4] beobachtet man es bald vor der Befruchtung, bald nach der Bildung von Endospermzellen.

(1) Ann. Bot. **26** (1912), 903.
(2) Journ. Agr. Res. **19** (1920), 393.
(3) BRENCHLEY berichtete bei Gerste, dass die Kernzerbrechung von beiden Enden des Endosperms aus beginnt, doch bei Weizen nahe der Embryospitze wie bei Reis (Journ. Agr. Soc. **3** (1909), 197.).
(4) l. c.

TERADA[1] sah aber diese Erscheinung zur Zeit der ersten Teilung des Endospermkernes.    Auf das Vorhandensein der abnormalen Kerne bei der Blühzeit gestützt, möchte ich eher annehmen, dass diese Erscheinung schon zu dieser Zeit eintreten wird.

5–6 Stunden nach der Bestäubung, wird die Entartung bemerkbar, d.h. die Zellmembranen verschwinden, einige Kerne vereinigen miteinander und die grossen Zellen zu Tage treten; überdies treten eine grosse Menge Körnchen,[2] die mit Farbstoffe gefärbt werden können, auf (Fig. 31).    Der letzte Zustand dauert während 18 Stunden nach
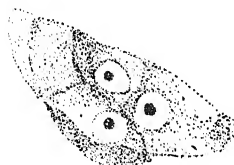


Fig.  31.                    Fig.  32.                    Fig.  33.

Fig. 31–33.   Die degenerierenden Antipodalzellen.   (× 850)

der Bestäubung, wonach diese Körnchen plötzlich verschwinden.    Zu dieser Zeit kann ich die Kerne, die sich wieder teilen und im Verschwinden begriffen sind, klar sehen (Fig. 32).    Nach weiteren 4 Tagen kann man die degenerierten Antipoden bloss als inhaltslose Zellen erkennen (Fig. 33).

## Kornbildung

### (1)  *Morphologische Veränderung*

Nach dem Spelzenschliessen beginnen die Narben zu verwelken und der Fruchtknoten fängt sich zu entwickeln an.    Einige Forscher, wie MINAMI[3] und UCHIDA,[4] besonders der letztere, haben schon ihre Beobachtungen über die morphologische Veränderung des Kornes beim Reis veröffentlicht.    Um kennen zu lernen, wie nach dem Blühen das Korn sich entwickelt, habe ich darüber eine kleine Beobachtung gemacht.

Die im Augenblicke des Blütenöffnens ganz frisch aussehenden Narbenäste beginnen nach einigen Stunden von Grunde aus zu vertrocknen.

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(1)   l. c.
(2)   KUWADA nennt diese Körnchen „mitochondria-like bodies."
(3)   Vererbungslehre (1926), 962.
(4)   Journ. Soc. Agr. For. Sapporo **59** (1922), 1.

Nach einem Tage: die Narbenäste vergilben und die Frucht-knoten vergrössen sich, besonders in Länge.

Nach zwei Tagen: die Narben vertrocknen sich gänzlich, die bisweilen an der Spitze des Korns sich kleben. Das Korn wächst besonders üppig an sowohl am oberen Ende als auch an der gegen die Aussenspelzen gerichteten Seite, wo das Chlorophyll manchmal im Verschwinden begriffen ist.

Nach drei Tagen: die Narben sterben gänzlich ab und hängen herab. Wie bei vorigen Tagen ist die Entwicklung des Kornes in Länge merkwürdig gross, und seine Spitze kommt schon in Berührung mit den inneren Spelzen. In diesem Stadium kann man kaum von aussen aus den entwickelnden Embryo erkennen.

Nach fünf Tagen: kein Spur von Narbenresten ist mehr sichtbar und das Korn, das innerhalb innerer Spelzen liegt, zeigt eine kleine Schwellung am Rücken. Die Bauchseite des Kornes, wo der Embryo sitzt, vergrössert sich etwas.

Nach sieben Tagen: das Korn erreicht jetzt die Spitze der Spelzen, woher man sehen kann, dass seine Entwicklung in Breite und Dicke sehr ausgezeichnet schnell ist. Trotz der dicken Samenhaut kann man dadurch den Embryo im Samen nachweisen, indem sie ganz chlorophyllfrei ist, da wo er liegt. Eine Schwellung wird auch an der Bauchseite gebildet.

Nach zehn Tagen: das Korn füllt ganz den Raum zwischen den Spelzen, und danach zwei Schwellungen befinden sich an den Rändern der inneren Spelzen.

Nach zwölf Tagen: das Korn nimmt den ganzen Innenraum beider Spelzen und zwei andere Schwellungen befinden sich an der Ecke äusserer Spelzen.

Nach fünfzehn bis zwanzig Tagen: der Embryo vergrössert sich mit der Zeit, doch bleibt die Samenhaut lange Zeit grün.

## (2)  *Wachstum der Körner*

Die zahlenmässige Studien des Körnerwachstums ist eine land-wirtschaftlich höchst wichtige Sache, sodass einige Autoren[1] schon darüber ihre respektive eingehende Mitteilungen veröffentlich haben. Das folgende ist das Resultat meiner kleinen Studien.

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[1] ANDO in Tokyo (Report Imp. Agr. exp. Station 17 (1901), 20); UCHIDA in Hok-kaido (l. c.); YAMAZAKI in Morioka (Sci. Res. Morioka Agr. Coll. 3 (1926) 73 u. 4, (1927), 159); MATSUDA in Kyoto (Journ. Sci. Agr. Soc. Japan 314 (1929), 1); SUZUTA in Taiwan (Rep. Agr. exp. Station, Formosa 57 (1928), 1).

TABELLE

| Tage nach dem Blühen | 1 | 2 | 3 | 5 | 7 |
|---|---|---|---|---|---|
| Länge (m.m.) | 1.373±0.032 | 2.366±0.047 | 3.380±0.048 | 5.462±0.072 | 5.652±0.031 |
| Breite (m.m.) | 0.629±0.014 | 0.780±0.018 | 0.965±0.018 | 1.581±0.024 | 2.357±0.071 |
| Dicke (m.m.) | 0.546±0.009 | 0.688±0.019 | 0.871±0.023 | 1.414±0.022 | 1.690±0.034 |

Aus Tabelle IV kann man klar sehen, dass das Längenwachstum 10 Tagen nach dem Blütenöffnen zum Ende kommt und das maximale Wachstum am 3. oder 4. Tage stattfindet. Ebenso kann man sehen, dass das Breitenwachstum nach 2 Wochen beendet ist und das Maximum am 3.–5. Tage geschieht. Selbstverständlich müssen die Aussenbedingungen, besonders die Wärme einen grossen Einfluss auf die Kornbildung ausüben.[1]

### (3) *Keimfähigkeit*

ANDO[2] und KONDO[3] haben die Keimfähigkeit der milchreifen Körner studiert. Aber es wird von einigem Interesse sein, die Frage zu studieren, wann und wie die entwickelnden Körner mit der Zeit ihre Keimfähigkeit bekommen werden. An verschiedenen Tagen nach dem Aufblühen werden auf dem Bette die Keimfähigkeit von je 20 Körnern versucht. Das Ergebnis wird in Tab. V und Fig. 34 angegeben.

### TABELLE V

| Tage nach dem Aufblühen | 5 | 7 | 10 | 12 | 14 | 16 |
|---|---|---|---|---|---|---|
| Nr. d. gekeimten Körner | 0 | 3 | 5 | 13 | 19 | 18 |
| Keimungsprozent (%) | 0 | 15 | 25 | 65 | 95 | 90 |
| Tage bis Keimung | 0 | 26 | 24 | 17 | 4 | 4 |

(1) YAMAZAKI und SUZUTA fanden enge Beziehung zwischen Wärme und Kornbildung (l. c.).

(2) l. c.

(3) Ber. Ôhara Inst. landw. Forsch. **2** (1921), 29.

IV

| 10 | 12 | 15 | 20 | etwa 50 (Vollreife) |
|---|---|---|---|---|
| 5.982±0.040 | 5.871±0.021 | 5.929±0.056 | 5.819±0.056 | 5.468±0.042 |
| 3.206±0.043 | 3.370±0.027 | 3.335±0.036 | 3.429±0.021 | 3.309±0.035 |
| 1.919±0.037 | 2.082±0.031 | 2.230±0.028 | 2.272±0.024 | 2.294±0.021 |
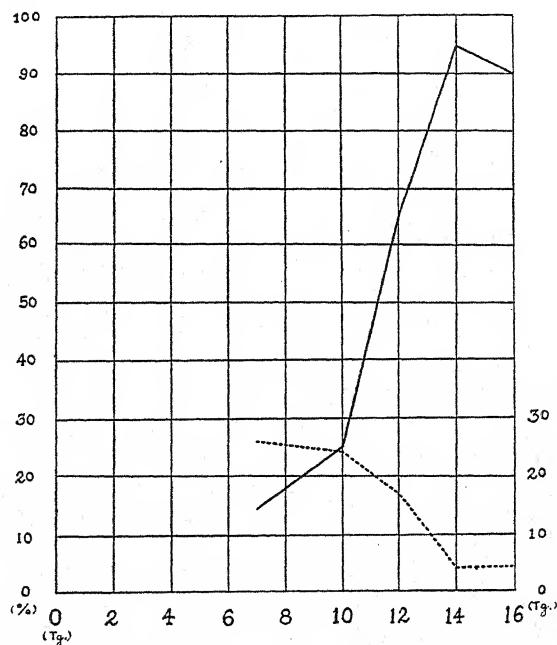


Fig. 34.  Die obere Kurve zeigt die Keimfähigkeit des Korns nach
dem Aufblühen; Ordinate = prozentige Zahl der gekeimten
Körner, Abszisse = Tage nach dem Blühen.   Die untere
Kurve zeigt den Zeitlauf von dem Aussäen bis zur Kei-
mung; Ordinate = Tage bis zum Keimungsanfang.

Man kann daraus sehen, dass am 5. Tage nach dem Blühen, wobei
keine Gegliederung noch im Embryo zu sehen ist, die Körner gar nicht
keimen können, ausgenommen eine kleine Anzahl, welche nach 7
Tagen zur Keimung gekommen ist.   Danach wird die Keimfähigkeit
der Körner immer grösser mit der Zeit und am 13. Tage nach der

Befruchtung erreicht sie etwa 95 % ; je länger die Zeit nach dem Blühen ist, je früher keimen die Körner, da dann der Embryo vollentwickelt ist.

## Zusammenfassung

1.   Im Gebiete der Reiszüchtung ist die genaue Kenntnis der Befruchtung und Kornbildung von Reis eine unbedingte Erfordernis. Seit 1926 war ich mit einer Untersuchung über die in Rede stehenden Erscheinungen bei zwei Reissorten Aikoku und Schinriki beschäftigt.

2.   Das auf die Narbe gefallene Pollenkorn beginnt sofort zu keimen, und etwa nach 1 Stunde dringt der Schlauch in die Narbe ein. 9 Stunden nach der Bestäubung gelangt der Pollenschlauch zur Mikropyle und zerbricht an seiner nahe der Eizelle gelegenen Spitze, woraus zwei Spermakerne herausgehen.

3.   Unter zwei spiralförmigen Spermakernen kommt der eine ganz nahe dem Eikerne und der andere geht in die Polkerne.  Die männliche und weibliche Kerne in der Eizelle bleiben lange unvereinigt und danach findet ihre Verschmelzung statt.  Der zweite Spermakern fängt dann mit Polkernen zu vereinigen an.  Die oben genannte Erscheinung weist auf die Doppelbefruchtung bei Reispflanzen hin.

4.   Während einiger Zeit bleibt der Embryokern unverändert und dann tritt der erste Kernteilungsvorgang plötzlich ein.  Etwa 24 Stunden nach der Bestäubung kann man den aus 4–7 Zellen gebildeten Embryo finden.  Nach 4 Tagen zeigt der Embryo das erste Zeichen der Differentiation, und während nachfolgenden 10 Tagen wird er sich vollständig entwickeln.

5.   Der erste Endospermkern teilt sich, ohne sofort durch die Zellbildung gefolgt zu werden ; die Vermehrung des Kerns setzt danach weiter fort und einige Dutzende Kerne sind schon nach 12 Stunden produziert.  Die Bildung der Zellmembran tritt nach 3–4 Tagen ein und binnen 10 Tagen füllen die Endospermzellen den ganzen Embryosack.

6.   In Endospermzellen fand ich das erste Auftreten der Stärkekörnchen am 7. Tage nach dem Blühen; sie vergrössern sich mit der Zeit.

7.   Die Synergiden und Antipodalzellen beginnen schon bei Blühzeit die Artungserscheinungen zu zeigen.  Etwa nach 24 Stunden wird kein Spur der ersteren mehr nachweisbar, während die letzteren noch 4 Tage als inhaltslose Zellen bleiben.

8. Ausserdem habe ich die morphologische Veränderung des Kornes, das zahlenmässige Verhältnis des Körnerwachstums und die Keimfähigkeit der entwickelnden Körner studiert.

Am Schluss ist es mir ein angenehmes Pflicht, meinem hochgeehrten Lehrer, dem Herrn Prof. Dr. M. So für Anregung und Leitung meiner Arbeit und Herrn Prof. Dr. H. Ando für den mir ständig gewährten Rat und gütige Hilfe meinen herzlichsten Dank auszusprechen.

# Karyological Studies of *Iris Kaempferi*, SIEB.

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*Iris Kaempferi*, SIEB. is found wild in Japan, Korea, Manchuria and Siberia. In Japan it has been cultivated in gardens as a horticultural plant for a long time, and we have now hundreds of garden varieties as the results of crossing, at least in part. The morphological differences of these garden varieties are chiefly noticeable in the characteristics of the flowers, that is, in the colour, size, form, and number of perianths. The wild form (*I. Kaempferi*, SIEB. var. *spontanea*, MAKINO) is, on the whole, strikingly smaller in size than the garden varieties (*I. Kaempferi*, SIEB. var. *hortensis*, MAKINO), and its perianths are purplish red.

*I. pseudacorus*, *I. squalens* and *I. germanica* were studied karyologically by STRASBURGER (1900), and *I. pseudacorus*, *I. spuria*, *I. florentina* and *I. pallida* by MIYAKE (1905). According to these authors the haploid number of chromosomes is 12 in all of these plants. KAZAO (1928) recently added some different numbers to this list of *Iris* chromosomes, $n=12$ in *I. Kaempferi*, $n=14$ in *I. sibirica*, $n=16$ in *I. laevigata*, $2n=48$ in *I. florentina*, $n=18$ in *I. gracilipes* and $2n=54$ in *I. japonica*.

Since 1926 I had been carrying out karyological investigations on some garden varieties of *I. Kaempferi*, SIEB. and the wild form, with special attention to the question whether or not there is any variation in the chromosome number among these varieties, and also to certain irregularities in the process of meiosis which we may meet with in hybrids naturally or artificially raised.

## Material and Method

Materials were taken from garden varieties cultivated in the botanical gardens of the Kyoto Imperial University and the gardens of Horikiri in the suburbs of Tôkyô, and from the wild form grown in Senjô-ga-hara of Nikkô. Somatic cells were studied with root-tips.

As a fixing fluid the Bonn modification of FLEMMING's solution was employed. Sections were cut 12$\mu$ thick, and stained exclusively with HEIDENHAIN's iron-alum haematoxylin. The studies of meiosis were made with pollen mother-cells. Materials were fixed in BOUIN's fluid, NAWASCHIN's fluid, the stronger and weaker solutions of FLEMMING's mixture, the Bonn modification of FLEMMING's solution and BENDA's modification of the same solution. Among these fixatives BOUIN's fluid was found to give the most satisfactory results for later stages after diakinesis, while the Bonn modification was the best for early prophase, details of prophasic nuclear threads being distinctly presented and thus the development of the threads being clearly traceable. Sections were cut 5-17$\mu$ thick according to requisites, and stained exclusively with HEIDENHAIN's iron-alum haematoxylin.

## Observation

### 1. The Number of Chromosomes

Observations of pollen mother-cells were made on eight garden varieties and the wild form, and those of somatic cells were made in root-tips of eighteen garden varieties and of the wild form. No difference was found in the number of chromosomes among them. In all of them the haploid number was 12 and the diploid 24 (Textfig. 1).

The number of chromosomes in the plants was determined as follows.

| Plant name | Chromosome number | |
|---|---|---|
| | in root-tips | in pollen mother-cells |
| ? | 24 (Textfig. 1, a) | |
| ? | 24 ( ,, b) | |
| ? | 24 ( ,, c) | |
| "Zama-no-mori" | 24 ( ,, d) | 12 |
| "Kurokumo" | 24 ( ,, e) | 12 |
| ? | 24 ( ,, f) | |
| "Matsubagasane" | 24 ( ,, g) | |
| ? | 24 ( ,, h) | |
| "Shiga-no-uranami" | 24 ( ,, i) | 12 |
| "Nanakomachi" | 24 ( ,, j) | 12 |
| "Jûnihitoe" subf. *pentapetala* | 24 ( ,, k) | 12 |
| "Mandai-no-nami" | 24 ( ,, l) | 12 |
| "Suibijin" | 24 ( ,, m) | 12 |
| "Ônarumi" | 24 ( ,, n) | |
| "Gyokuhôren" | 24 ( ,, o) | |
| "Iwato-no-hikari" | 24 ( ,, p) | |
| "Edojiman" | 24 ( ,, q) | |

| "Chôseiden" | 24 (Textfig. 1, r) | 12 |
| "Nohanashôbu" (wild form) | 24 ( „ s) | 12 |

Morphological details of the garden varieties are referred to in MIYOSHI's "Hanashôbu-Zufu".
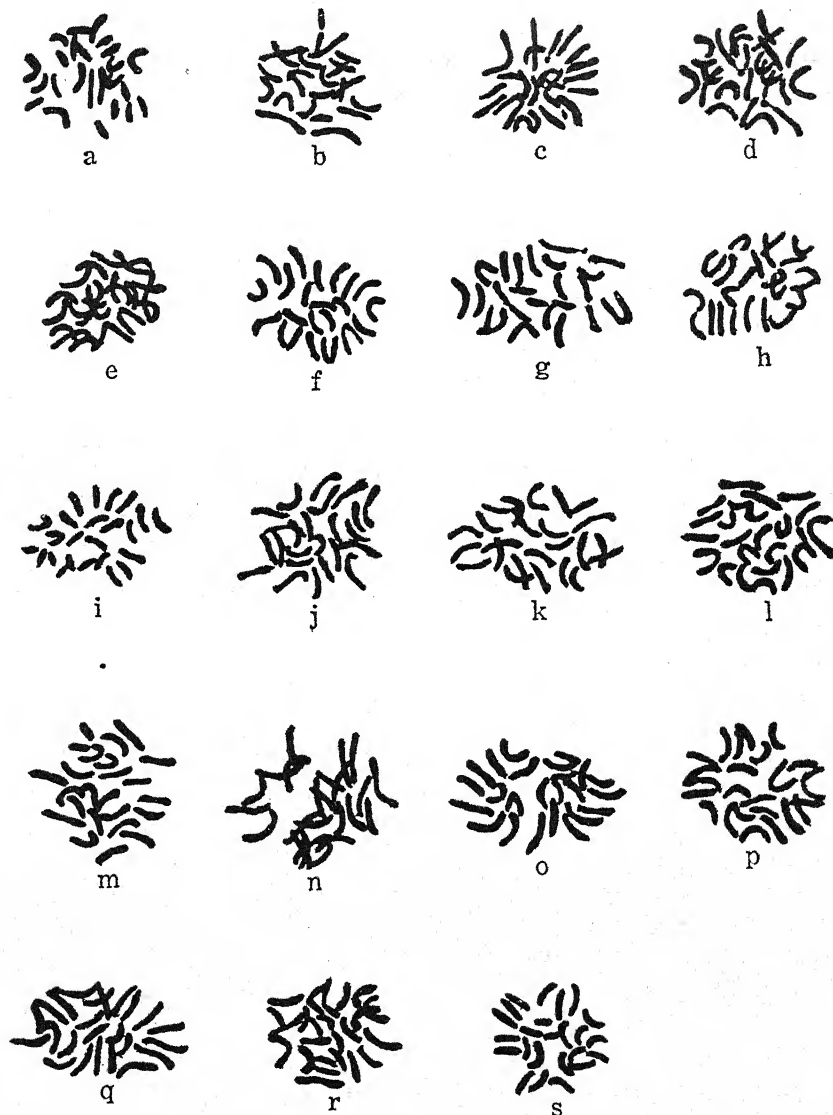


Textfig. 1. Chromosomes in the nuclear plate from the root-tips of the various plants. Explanation in the text. ×1300.

## 2. Meiotic Divisions in Pollen Mother-cells

### a. NORMAL CASE

*Presynizesis stages and Synizesis.* In *Iris Kaempferi*, as the nucleus passes over from the last premeiotic telophase to the interphasic condition a certain number of paired chromatic bodies is found in it (Fig. 1). These bodies are connected with achromatic fine filaments which run irregularly in the nucleus. At this stage the nucleus contains one large nucleolus, sometimes two or more of somewhat smaller sizes. In the next stage we find fine chromatic threads running irregularly which may have their genetic connection with the paired chromatic bodies just described (Fig. 2). As the stage approaches synizesis the threads become smoother (Fig. 3). Fig. 4 represents a nucleus in the stage just before synizesis and shows a certain parallelism observable in places in the arrangement of the threads.

The withdrawal of the threads from the periphery of the nucleus marks the beginning of synizesis. The threads gradually contract and form a tight knot at one side of the nucleus, the nuclear cavity markedly growing in size at the same time (Fig. 5). The nucleus in the stage of synizesis usually takes an excentric position in the cell. In a very thin section $5\mu$ thick a certain parallelism in the arrangement of the threads is here and there recognizable, but the threads being extremely fine and tightly pressed to a mass, an exact observation is hardly possible. During the synizesis the threads become gradually thicker, and the synizetic ball of the threads begins to loosen again. In this period paired arrangement of the threads is clearly observable (Fig. 6).

*Hollow Spireme.* In early pachynema the double nature of the threads is seen here and there (Fig. 7). When the differentiation in staining is carefully carried out, the early pachytene threads exhibit an alternation of dark coloured areas with lighter ones. Such differentiation in colour is more marked in the hollow spireme (Fig. 8). In the hollow spireme it is very difficult to determine whether the threads form a continuous thread or not. In the majority of cases no free end of the threads was found, but the whole appearance gave an impression as if there was only one long, continuous thread. In the material used in many cases, the thread was apparently single, but in properly fixed materials the double nature could be seen in certain portions of the thread (Figs. 9a and 9b). Therefore, the nuclear thread which emerged

out of the synizetic knot seems to be longitudinally double throughout pachynema stage. When the fixation is imperfect, the two components of the threads associate so compactly with each other, that they give an appearance of a single thread.

*Second Contraction and Segmentation.* Condensation of the spireme thread then follows. The thread is uneven in thickness throughout the length (Fig. 10.). In this stage the double nature of the thread becomes clear, the longitudinal compact association of the components being loose throughout the whole spireme thread. The segmentation begins at the thinner portions of the thread (Figs. 11, 12, 13 and 14). In this plant, usually, several pairs of these chromosome segments are found converging to a point near the center of the nucleus, sometimes having the nucleolus at the center of the convergence. This state of chromosome aggregation makes closer observations at the center very difficult. In the periphery of the nucleus, on the other hand, free ends of the chromosomes are clearly seen arranged in pairs (Fig. 15). Such an arrangement of chromosomes, sometime, gives an appearance of loops, but closed loops which would support the theory of telosynapsis were not found.

A chain or ring composed of a number of chromosomes is, sometimes, found in the stage after segmentation (Figs. 17 and 18). Such a chain or ring complex of chromosomes may be taken as an evidence of telosynapsis. They may, however, be regarded as a result of the opening out of a paired chromosome complex which had not yet segmented (Fig. 16). KIHARA (1927) describes two types of arrangement of chromosome complex in *Rumex acetosella*. The one is the double chain arrangement ("Doppelkettenanordung"), and the other is the radial arrangement ("Radialanordung"). According to his opinion the chromosome ring is formed by the opening out of paired chromosomes originally arranged side by side. MIYAKE (1906) observed in details the processes of reduction division of *Iris* and has come to the conclusion that in *Iris* the mode of syndesis is parasynaptic.

*Diakinesis.* As a result of the continued shortening and thickening of the double threads, bivalent chromosomes of diakinesis are formed. In the early diakinesis the bivalent chromosomes sometimes appear as a cross, or a ring or a V, as a loop which opens at one end, or as two rods which lie side by side (Fig. 19). Some pairs of chromosomes present a constriction in the middle and they not infrequently look like a tetrapartite complex (Fig. 23, a). This constriction of the chromosomes can also be seen in the early anaphase. In some garden varieties

## TABLE  I.

| Plant name | Number of unpaired chromosomes | | Number of paired chromosomes | Number of nuclei observed |
|---|---|---|---|---|
| "Mandai-no-nami" | | 24 | 0 | 3 |
| | | 22 | 1 | 2 |
| | | 20 | 2 | 3 |
| | | 16 | 4 | 4 |
| | | 14 | 5 | 2 |
| | | 12 | 6 | 6 |
| | Total number observed | 340 | 70 | 20 |
| | Average number in one nucleus | 17 | 3.5 | |
| "Shiga-no-uranami" | | 22 | 1 | 1 |
| | | 20 | 2 | 5 |
| | | 18 | 3 | 5 |
| | | 16 | 4 | 3 |
| | | 14 | 5 | 2 |
| | | 12 | 6 | 4 |
| | Total | 336 | 72 | 20 |
| | Average | 16.8 | 3.6 | |
| "Suibijin" | | 10 | 7 | 5 |
| | | 8 | 8 | 6 |
| | | 6 | 9 | 4 |
| | | 4 | 10 | 3 |
| | | 2 | 11 | 2 |
| | Total | 138 | 171 | 20 |
| | Average | 6.9 | 8.5 | " |
| "Jûnihitoe" subf. *pentapetala* | | 12 | 6 | 1 |
| | | 8 | 8 | 1 |
| | | 6 | 9 | 1 |
| | | 4 | 10 | 3 |
| | | 2 | 11 | 5 |
| | | 0 | 12 | 9 |
| | Total | 48 | 216 | 20 |
| | Average | 2.4 | 10.8 | |
| "Nohanashôbu" (Wild form) | | 2 | 11 | 32 |
| | | 0 | 12 | 18 |
| | Total | 36 | 384 | 50 |
| | Average | 0.7 | 11.6 | |

the affinity between the homologous chromosomes is very weak, so that they are often separated from each other and remain unpaired in the late diakinesis (Fig. 20). This premature separation may occur, though rarely, even in all the bivalents. The ratio between the numbers of the paired and unpaired chromosomes differs in different garden varieties as shown in Table I. (See the preceding page).

*Metaphase.* In the late diakinesis the nuclear membrane and nucleolus disappear. Sometimes we find in this stage a multipolar spindle which later becomes bipolar (Fig. 21). Some of the homologous chromosomes found separated from each other in diakinesis draw

## TABLE II.

Number of chromosomes, paired or unpaired, which have not arranged on the equatorial plate. (Observations were made in side view of the spindle figure).

| | Number of chromosomes / Name of plants | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| Number of nuclei | " Mandai-no-nami " | 4 | 11 | 18 | 21 | 15 | 8 |
| | " Shiga-no-uranami " | 7 | 20 | 29 | 19 | 5 | 2 |
| | " Suibijin " | 30 | 30 | 21 | 19 | 3 | |
| | " Jûnihitose " subf. *pentapetala* | 40 | 11 | 6 | 5 | 1 | |
| | " Nohanashôbu " (Wild form) | 45 | 9 | 1 | | | |
| Ratio taking the case 0 as unit | " Mandai-no-nami " | 1 | 2.75 | 4.50 | 5.25 | 3.75 | 2.00 |
| | " Shiga-no-uranami " | 1 | 2.85 | 4.14 | 2.71 | 0.71 | 0.29 |
| | " Suibijin " | 1 | 1.00 | 0.70 | 0.63 | 0.10 | |
| | " Jûnihitoe " subf. *pentapetala* | 1 | 0.28 | 0.15 | 0.13 | 0.03 | |
| | " Nohanashôbu " (Wild form) | 1 | 0.20 | 0.02 | | | |

nearer again to form gemini, and take part in the formation of the
nuclear plate, while others still remain single in the metaphase and lie
out of the nuclear plate.   In some varieties all the chromosomes are
not evenly arranged in the equatorial plate, but some above or below
it, sometimes some being found scattered even near the poles (Fig. 22).
The number of paired and unpaired chromosomes which lie out of the
equatorial plate differs in different varieties, and in the wild form such
are very few in number as is seen in Table II.  (See the preceding page).

*Anaphase*.   In the anaphase all bivalent chromosomes do not
segregate at the same time.   One may segregate at first to poles
(Fig. 24), and then the others, one after another (Fig. 25).   Sometimes
some bivalents still remain in the equatorial plate, when the others
have already reached near the poles (Fig. 28).   These lagging bivalents
segregate ultimately and go to opposite poles, generally taking part
with the others in the formation of the interkinetic nucleus, but
sometimes do not reach the poles and form a small isolated nucleus
(Fig. 30).   When there are unpaired chromosomes, they often go to
poles quite at random.   In such a case the number of chromosomes at
the poles may be different.   While the bivalent chromosomes are
generally of more or less irregular spherical shape in the heterotypic
metaphase, they are of various shapes in the meta-anaphase and
anaphase as are shown in Fig. 26.   The longitudinal split of chromo-
somes appears more or less clearly in these stages (Fig. 27).

The abnormalities in behaviour of the chromosomes observed in the
stages from diakinesis to anaphase may be regarded as being due to
the hybrid nature of the plants, because in the wild form, the behaviour
is more normal as is seen in Tables I and II.   There are certain differ-
ences among the different varieties in the degree of irregularity in the
behaviour of chromosomes.   The greater the number of unpaired
chromosomes found in diakinesis, the higher the degree of the irregular
arrangement of chromosomes in metaphase.

The unpaired condition of chromosomes and their behaviour in the
division have been observed in many plants of hybrid nature, for
instance, in pollen mother-cells of *Hieracium laevigatum* and *H. lacerum*
observed by ROSENBERG (1926–27), and in *Raphanus-Brassica* hybrid by
KARPECHENKO (1927).   In these cases all the chromosomes may them-
selves contribute to the formation of only one interkinetic nucleus, so
that the end result is not a tetrad, but a diad.   NAWA (1928) has reported
the existence of univalents mixed with bivalents in pollen mother-cell
of the hybrid between *Tricyrtis hirta* and *T. stolonifera*.

STOW (1927) in *Solanum tuberosum* and TAKAGI (1928) in *Lychnis Sieboldii* observed such a failure of the formation of gemini as seen in hybrid plants, in pollen mother-cells of those plants which were subjected to higher temperatures. SHIMOTOMAI (1927) also found the unpaired condition of chromosomes in pollen mother-cells of *Liriope graminifolia* which were cooled at 0°C for seven hours. The results of these experiments show that the normal behaviour of chromosomes is strikingly disturbed by the influence of temperature, so that the division is abnormal.

In experiments, made in 1927 concerning the influence of temperature upon the process of meiotic division of *Iris Kaempferi*, it was found that in both cases of high (35°–45°C) and low (2°C) temperatures to which the materials were subjected for several hours, the number of unpaired chromosomes was more or less increased as compared with the

TABLE III

Atmospheric temperature in May, 1927

| Date | Maximum (degrees in C.) | Minimum (degrees in C.) |
|---|---|---|
| 15 | 19.4 | 12.0 |
| 16 | 19.0 | 9.0 |
| 17 | 21.1 | 7.7 |
| 18 | 20.7 | 15.7 |
| 19 | 20.7 | 8.4 |
| 20 | 23.6 | 13.4 |
| 21 | 24.5 | 8.0 |
| 22 | 26.8 | 17.6 |
| 23 | 21.7 | 6.5 |
| 24 | 23.6 | 15.0 |
| 25 | 19.7 | 15.1 |
| 26 | 24.3 | 16.9 |
| 27 | 26.8 | 11.7 |
| 28 | 26.4 | 7.5 |
| 29 | 23.1 | 9.8 |
| 30 | 24.0 | 7.7 |

results obtained from the natural materials.    While these experiments were being carried out on the one hand, variations of atmospheric temperature in the botanical gardens of the Kyoto Imperial University where the material was collected were recorded on the other hand. These are shown in Table III.   We find in this table fairly marked variations.    Moreover, cool water was occasionally irrigated into this garden.   Therefore, the actual variations of temperature which influence the plants may be greater than we might expect from the variations of atmospheric temperature.    By the influence of these natural variations in temperature, the normal behaviour of chromosomes in pollen mother-cells of these plants may be disturbed, if the plants are sufficiently sensitive.   In his experiment STOW states that the abnormal behaviour of chromosomes in *Solanum tuberosum* is neither connected with the hybrid nature of the plant nor with its nutritive condition, but is rather due to the environmental condition or a certain special nature of the plant itself.    KUWADA (1928) states:—" There is an internal tendency to respond to external or environmental conditions.    This tendency may be strong in one plant, and weak in another.   In plants where it is very strong, such peculiarities as what is called the restitution-nuclei would be almost of normal occurrence, because in such plants a slight change in temperature, etc. will cause the peculiarities." He has also stated:—" Hybrid plants consist of two different genotypical complexes, hence, if the difference between the complexes is sufficiently large, a certain disturbance may be expected in the normal physiological equilibrium that has been maintained in the homozygous state.    In such a disturbed condition in the protoplast, the plants are in a less consistent state and may have more tendency to respond to an abnormal environmental condition than the normal plant, thus it does not seem improbable that they may show a certain abnormal behaviour, even in a slight change in the environmental conditions to which normal plants do not respond at all."    The garden varieties of *Iris Kaempferi* are not of pure lines, but may be of hybrid nature.    In these varieties, therefore, the normal physiological equilibrium in protoplast may easily be disturbed by so slight a variation in temperature as we have in nature, resulting in the abnormal behaviour of chromosomes such as those mentioned above.    Thus the difference in degree of the disturbance of chromosome behaviour in different varieties may be regarded as depending on the difference in their tendency of responding to temperature.    In the wild form this tendency is very weak, so that the chromosome behaviour is normal.

*Telophase and Interkinesis*. In the telophase, though occasionally, the longitudinal split of chromosomes is seen in most of the 12 chromosomes (Fig. 29). The split chromosomes become longer and slender. The nuclear membrane then appears, and the daughter-nuclei contain one or more nucleoli in them. They never enter the full resting condition (Figs. 30 and 31). The chromosomes in the interkinesis split lengthwise, both longitudinal halves of the chromosome adhering with each other at a certain portion, or being completely separated from each other throughout their length (Figs. 32 and 33).

In the heterotype division of *Iris* the cell-plate is not formed, though a rudimental cell-plate is seldom seen across the phragmoplast (Fig. 31). Not infrequently a certain indication of cytokinesis by constriction can be found (Fig. 31). Normally, however, the formation of the cell-plate never proceeds further in either case. In monocotyledons, most of the plants form cell-plate in the heterotype division as in the homeotype division. Thus *Iris* makes an exception, as already reported by MIYAKE.

*Homeotype division*. In the next stage both nuclear membrane and nucleoli of the interkinetic nuclei disappear. Longitudinal halves of the chromosomes become contracted and associated together more closely than in the interkinesis (Fig. 34). They then form the homeotypic nuclear plates (Fig. 35). The two spindles are formed so as to have their axes orientated at various angles with each other, from the right angle to parallel. The chromosomes are now slender as compared with those in the heterotype division. In the anaphase the chromosomes are divided and drawn to the poles (Fig. 36). In the telophase the chromosomes gradually draw nearer one another and come in contact at last (Fig. 37). They then become much more slender (Fig. 38). The four nuclei are found arranged at the end of the homeotype division in various relative positions which are determined by the angles between the two spindles. In some cells, for instance, they are arranged on different planes so as to form a tetrad being connected by spindle fibers, two by two in all possible ways (Fig. 39), while in some others they are found nearly in one plane. In each nucleus many granular chromatic bodies are found (Fig. 38). They seem to represent small nucleoli, because in the later stage they disappear, but instead of them one or two large nucleoli are seen (Fig. 39). The cell-membrane is formed simultaneously between the four nuclei, and four pollen-grains are finally formed (Fig. 40).

### b.  ABNORMAL CASE

In all the varieties observed, the processes of the meiotic division
were, generally speaking, normal in the most pollen mother-cells.
However, in some garden varieties, besides the irregularities mentioned
above certain abnormal cases were found.  They are briefly described
in the following few pages.

1.  Though seldom, we find two nuclei in one pollen mother-cell
which is usually larger than the normal ones.  So far as my observations
are concerned, both these nuclei develop independently from each other
throughout the processes of meiosis, but always progress with the same
stage.  The developing stage of these nuclei is, moreover, always the
same as that of other nuclei in the neighbouring normal cells.  Textfig.
2, a—i, show these binucleate pollen mother-cells in stages from the
heterotypic early prophase to the homeotypic telophase.  The number
of chromosomes were counted to be about 12 in each of these nuclei.
In some varieties unpaired chromosomes were also found in them as in
the case of the normal uninucleate cells (Textfig. 2, e).  When the
nuclear membrane disappears, the disappearance takes place simulta-
neously in both these nuclei, and two groups of the chromosomes are so
arranged as to form two distinct nuclear plates (Textfig. 2, f and g).
The bivalents disjoin, without mixing with those of the other group,
but keeping themselves within their own group, so that as the end
result of the heterotype division four daughter nuclei will arise.  In the
homeotype division every chromosome divides equationally without
mixing again with those of the other group.  Eight nuclei are, there-
fore, formed in one cell (Textfig. 2, i).  The end result is that eight
pollen-grains are produced from this binucleate pollen mother-cell as
will be expected from the eight nuclear state of the cell.  These
binucleate pollen mother-cells have been up to the present observed in
only four garden varieties, " Shiga-no-uranami ", " Mandai-no-nami ",
" Nanakomachi " and " Jûnihitoe subf. *pentapetala* ", and the wild
form, but they are probably found in the other varieties, too.  In *Iris
laevigata* FISCH such binucleate pollen mother-cells were also found,
each nucleus having 16 bivalent chromosomes.  Closer studies on this
plant are left for further investigation.

There may be two alternatives for explaining the origin of the
binucleate pollen mother-cells.  The one alternative is the fusion of
two cells, and the other is the nuclear division in the premeiotic phase
not accompanied with cell division.  I examined the matter through
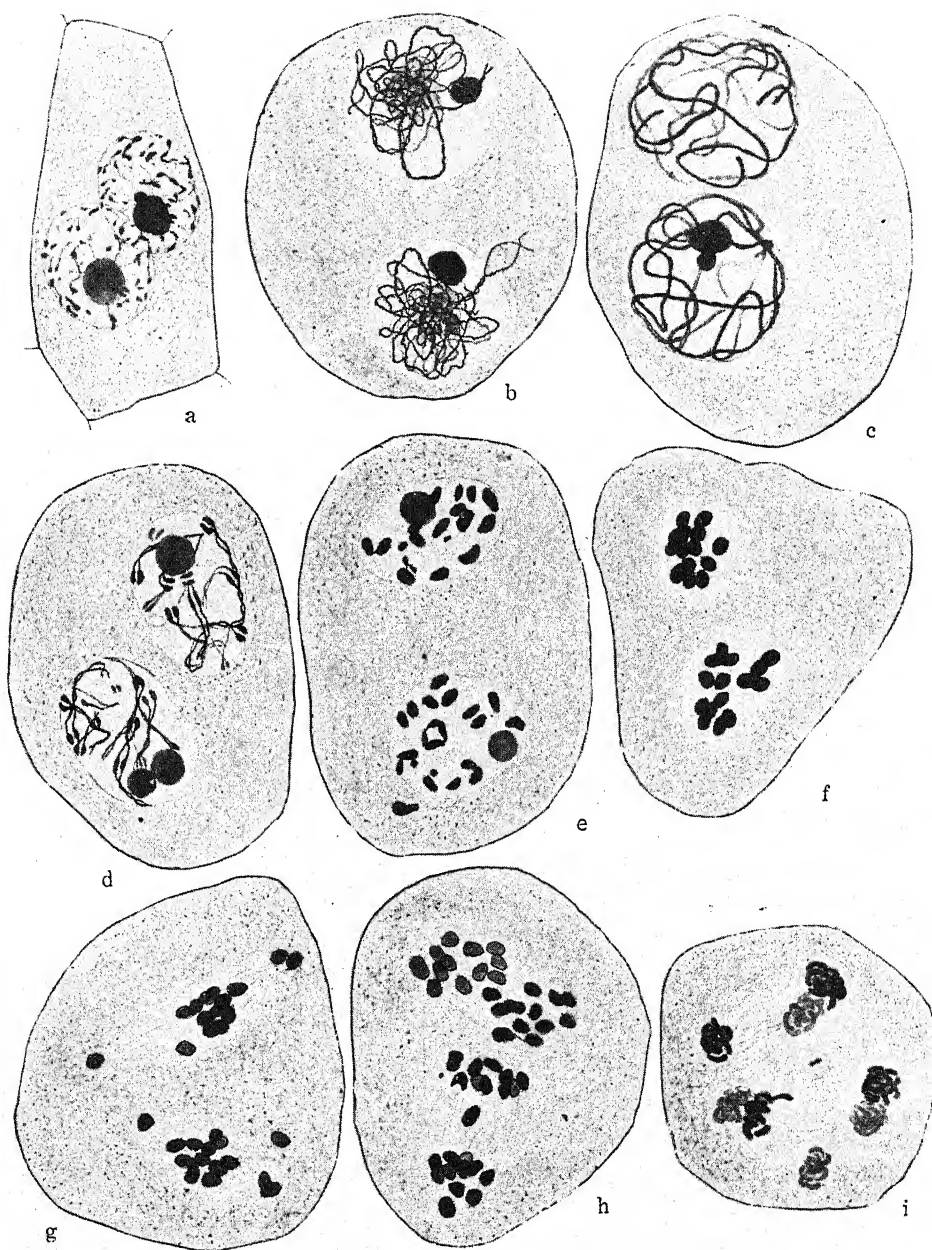
Textfig. 2, a—i. Binucleate pollen mother cells. ×1500. (Reduced to ⅘ ×1500) a. Early prophase. b. Early pachynema. c. Hollow spireme. d. Strepsinema. e. Diakinesis. f. Metaphase in polar view. g. Metaphase in side view. h. Anaphase. i. Telophase of the second division.

both meiotic and premeiotic phases to determine which of the alterna-
tives is right.  The binucleate cells were found in all the stages of
meiosis, even in the very early prophase of the heterotype division,
where the pollen mother-cells are closely in contact with each other and
take up polygonal shapes.  KARPECHENKO in his paper describes the
occurrence of the binucleate pollen mother-cells in *Raphanus-Brassica*
hybrid (9 × 9), and illustrates divisions of these binucleate cells in stages
after diakinesis.  According to his opinion, in the division of cells of
the archesporium preceding the reduction division, karyokinesis not
accompanied with cytokinesis may occur, this gives rise to the production
of pollen mother-cells with two nuclei, each containing 18 chromosomes.
In this hybrid the chromosomes in both nuclei remain unpaired.  At
the first division two spindles which originate from these two nuclei
fuse into one, and the chromosomes belonging to these two nuclei form
one nucleus without being distributed to the poles, so that the first
division is omitted.  In the second division the chromosomes are
longitudinally divided and their halves are distributed regularly to
poles.  As the result of this distribution there arise diads with 36
chromosomes in each cell, and from these diads, gametes with this
number of chromosomes are produced.

In *Iris Kaempferi*, however, as already mentioned above, both these
nuclei develop independently from each other without chromosome
mixing throughout all stages of meiosis.  Thus eight nuclei, each
containing 12 chromosomes in it are produced in one mother-cell.  So
far as my present observations are concerned, the formation of diads
such as reported by KARPECHENKO in his hybrid, was not met with.
Though I was not able to trace the critical phase elucidating the origin
of the binucleate pollen mother-cells, I am inclined at present to follow
KARPECHENKO's view.

2.  In pollen mother-cells of a variety "Shiga-no-uranami" and
some other varieties a peculiar manner of nuclear division such as found
by ROSENBERG (1926) in *Hieracium pseudoillyricum*, was observed.  In
these pollen mother-cells contraction of nucleus takes place in the
prophase of the heterotype division, so that the nucleus appears darker
(Textfig. 3, a and b).  When the membrane of these nuclei disappears
chromosomes longer than the usual bivalents are observed.  At first
they form a mass (Textfig. 3, c), but they soon become loose, and show
longitudinal splits (Textfig. 3, d).  Finally they gather in the equatorial
plate and then their longitudinal halves are divided into poles.  When
the spindle is formed the division figure is fairly regular (Textfig. 3, e),
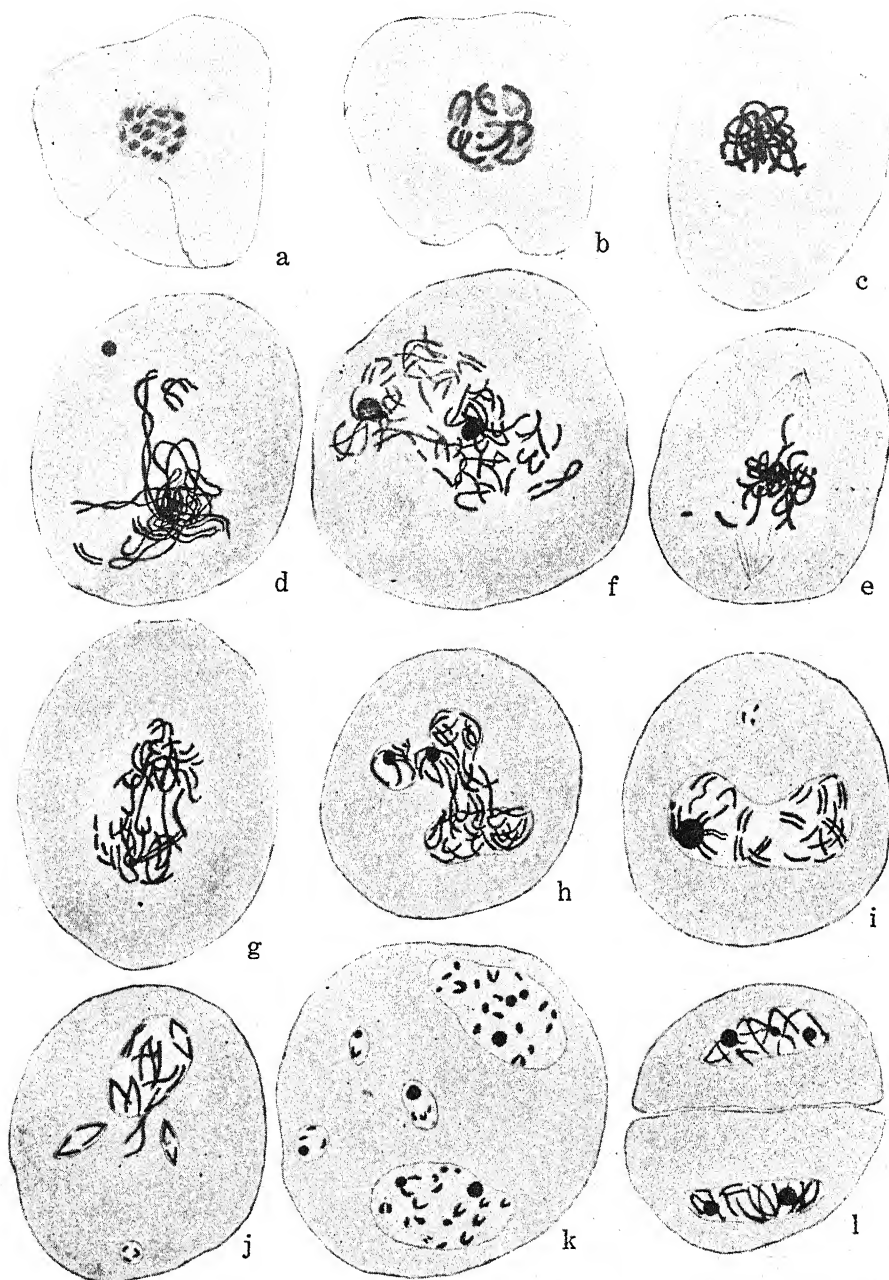
Textfig. 3, a−l.  Various stages of abnormal division.  ×1300.

a and b.  Nuclei are strikingly contracted.  c. Long chromosomes form a mass.  d. Longitudinal split of slender chromosomes is seen. e. A case where spindle is formed.  f and g. Chromosomes grouping in two main masses, f is oblique view.  h. Nuclear membrane is formed around the irregular mass of chromosomes.  i and j. Nuclei of different sizes which have been produced as the result of irregular division.  k. Later stage.  Chromosomes are contracted to short rods. l. A diad.

but not infrequently no spindle is formed and the chromosomes are divided irregularly into more than two groups, giving rise to nuclei of various sizes (Textfig. 3, f—k). When the chromosomes do not form distinct groups, being connected with one another by some chromosomes distributed between them, the formed nucleus or nuclei may give an appearance like those in amitosis (Textfig. 3, h). In those pollen mother-cells, the first division is completely suppressed and only the second division—equational division—takes place, so that the end result is not a tetrad, but a diad with the unreduced chromosome number (Textfig. 3, l).

3. The extrusion of the nuclear substance into an adjoining cell was observed in some pollen mother-cells of *Iris Kaempferi*. Concerning the nature of the phenomenon there are different views, and no agreement has as yet been reached. In the following, only a mere description of the phenomenon observed in this plant will be given. In some pollen-sacs the extrusion takes place markedly, especially in a stage slightly after synizesis. In other stages it was rather seldom observed. The shape of extruded chromatic bodies are multifarious as shown by SINOTÔ (1922) in *Iris japonica*. In my preparation besides these chromatic bodies, extrusion of the spireme threads was observed. When the spireme threads have just extruded through the narrow path, the extruded threads are, of course, found adhering with one another, but sometime after they spread out and form a spireme again. In the pollen mother-cells of *Oenothera* GATES (1911) describes that the extruded chromatin, though it at first forms a body as solid as a nucleolus, soon spreads out and forms a structure closely resembling the reticulum or spireme. In *Iris Kaempferi* several different cases were found with intermediate gradations: In some a small part of the spireme is extruded from the cell, and in others the greater part of the spireme is extruded (Textfig. 4, a and b). The nucleolus usually remains in the cell, but it may be also extruded (Textfig. 4, b) as described by SINOTÔ.

A clear area around the extruded chromatic bodies has been observed by some investigaters, and explanations as to its nature have been attempted. It seems to be probable that the extrusion of the karyolymph takes place here together with the chromatic bodies, and that the extruded karyolymph forms a clear area around the chromatic bodies, presenting an appearance of a limiting membrane between cytoplasm and the karyolymph itself. According to GATES the extruded material quickly forms a pseudonucleus by the accumulation of karyolymph and by the formation of the precipitation membrane at the
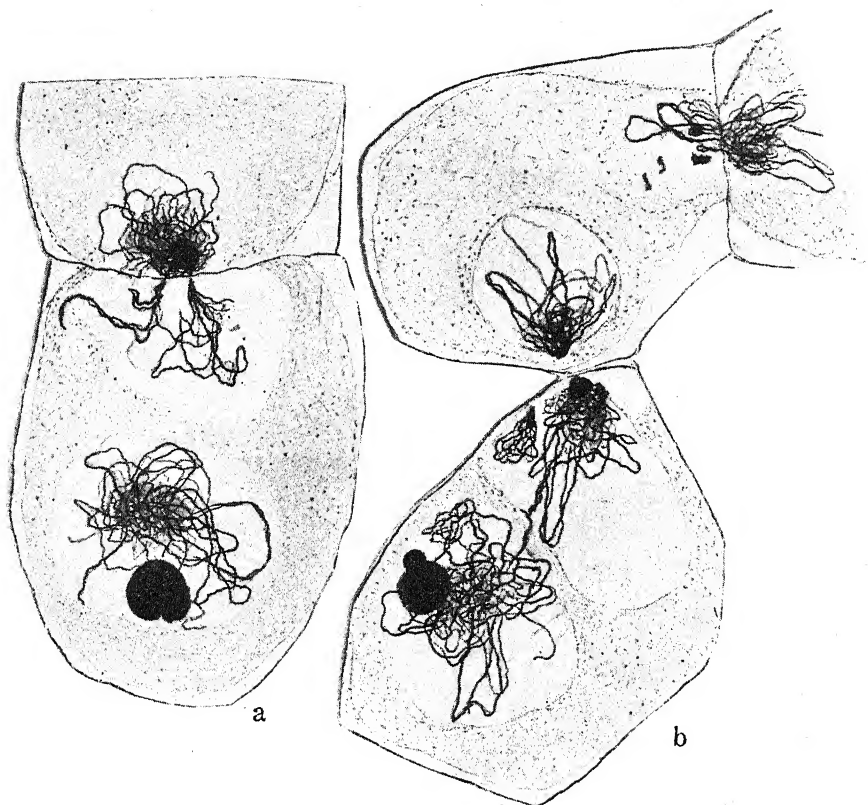
Textfig. 4, a and b.    Extrusion of nuclear substance.    ×1500.
a. Showing chromatic threads extruding from small pores.
b. Chromatic threads, nucleolus and karyolymph extruding
to form a pseudonucleus.

surface of the karyolymph where it is in contact with the cytoplasm.
KÖRNICKE (1901) states that when the extruded material forms a
pseudonucleus, having been separated from its original cell, the pollen
mother-cell will give an appearance of a cell containing two nuclei.

In *Iris Kaempferi* such a phenomenon, as stated by KÖRNICKE, was
also found (Textfig. 4, b).  In the upper cell shown in Textfig. 4, b,
more than one half of the spireme thread has been extruded together
with the nucleolus and karyolymph, and forms a pseudonucleus.  In my
experiments on the influence of temperature upon meiosis, the extrusion
of nuclear substances was more frequently observed in both cases of
low and high temperatures than in the case of the natural condition.

In these cases, though fixation was not so properly made as in the case of the other materials, and the extruded chromatic bodies appeared as masses of various shapes, the results seem to show that the variation in temperature may be regarded as one of the causes of the extrusion. If the variation of temperature is a cause, sensitive nuclei may be affected even by the relatively slight variation occurring in gardens, giving rise to the result of the extrusion.

RUTTLE (1928) regards the binucleate state of the pollen mother-cells found in *Nicotiana*—a state which we also found in *Iris Kaempferi*—as due to the extrusion of the nucleus of a cell into an adjoining cell on the basis of the fact that adjoining the binucleate pollen mother-cell on one side was a pollen mother-cell of normal appearance and on the other side an enucleate pollen mother-cell. In *Iris Kaempferi*, however, no enucleate cell was noticed in any of the adjoining cells of the binucleate cell.

So far as my observations go, notwithstanding the fact that there are some kinds of abnormal divisions which may give rise to pollen-grains furnished with variable numbers of chromosomes, not a single variety has been found which carries a different number of chromosomes. Though our observations have not yet been extended to the number of garden varieties sufficiently to draw a definite conclusion from the results obtained, it seems to be highly probable that the pollen-grains produced by the abnormal divisions mentioned above are mostly sterile. The fact that sterile pollen-grains are more abundantly found in the varieties where the abnormal divisions frequently take place than those where the division is normal may support this view.

## Conclusion and Summary

The paired arrangement of chromatic bodies can be seen in an early stage of the last premeiotic interphase. These chromatic bodies grow to fine filaments. They are found in places running parallel to each other even in the presynaptic stage. During synizesis and immediately after it the parallel threads tend to approach each other and then they form a spireme thread. In the early spireme the double nature can be seen here and there throughout the whole length of the spireme thread, but in the hollow spireme the thread appears to be single. Even in this case, in the properly fixed materials the double nature is observable. In the next stage the thread clearly appears to be double again with the

alternation of thinner and thicker portions throughout the length. Segmentation begins at the thinner portion of the thread. It is usually clearly observable near the periphery of the nucleus, the ends of the threads segmented being distinctly double. The whole appearance of the segmenting thread is like the cluster of loops which are said to be formed by the "second contraction", but it seems to me that such is not the case with our material. Sometimes chains or rings formed of some number of chromosomes are seen in the stage of the strepsinema. I am inclined to the view that they are formed by the result of the opening out of double chromosomes which have not completely segmented.

In certain varieties, some or even all the homologous chromosomes remain separate from each other and do not form gemini in diakinesis. In metaphase most of them form gemini, however, while some remain still unpaired. In most cases even the chromosomes forming gemini may not arrange themselves evenly on the equatorial plate. In anaphase all univalent chromosomes are distributed more or less regularly to poles along with other normal chromosomes originated from gemini, except a few cases of irregular distribution. These abnormalities in the chromosome behaviour may be due to the hybrid nature of the plants, because in the wild form the chromosome behaviour is more normal than that of the garden varieties. There are differences among different varieties in the degree of abnormality.

In most pollen mother-cells the end result of the division is the formation of a tetrad containing nuclei of equal size, except a few cases where the nuclei are of different sizes, being due to irregular distributions of the chromosomes.

In this plant cell-wall is never formed in the heterotype division, but is formed in the homeotype division simultaneously. In some few cases, however, a sign of cell-plate formation was observed, and occasionally a constriction at the surface of the protoplast, indicating cytokinesis.

In some varieties of this plant nuclear division takes place in a certain peculiar manner, the normal development of pollen mother-cells being suppressed. The nucleus in which the slender spireme-like chromosomes are contained divides only once, representing the homeotype division. Sometimes the division, being very irregular, results in more than two nuclei.

A case of binucleate pollen mother-cells was met with. So far as my observations go, both nuclei in the binucleate pollen mother-cells develop independently, and the chromosome of each nucleus never

mixes with those of the other. Eight nuclei are consequently produced from one mother-cell. In this plant, therefore, diploid gametes such as reported by KARPECHENKO in the case of *Raphanus-Brassica* hybrid are not produced from the binucleate mother-cells.

The extrusion of nuclear substance into an adjoining cell was observed. This phenomenon is seen more frequently in material which has experimentally been subjected to unnatural temperatures.

So far as my present investigations go, there is no variation in the chromosome number among the different varieties observed, though several abnormal nuclear divisions have been found in some number of cases.

This investigation was begun in the Botanical Institute, Kyoto Imperial University under the direction of Professor KUWADA and since then, it was continued in the Tokugawa Institute for Biological Research. I wish to express my sincere thanks to Prof. KUWADA for his kind advice and invaluable suggestions. My thanks are also due to Professor HATTORI, Director of the Tokugawa Institute, for the constant encouragement and the facilities kindly offered me in pursuance of this investigation.

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# Explanation of Plates XXXV—XXXVII

All figures were drawn with the aid of ABBE's camera lucida. For all the figures except Figs. 9a, 9b and 12, ZEISS oil imm. $\frac{1}{12}$ and comp. oc. 12 were used. For Figs. 9a, 9b and 12, ZEISS apoch. imm. 2mm. and comp. oc. 18 were used.

Fig. 1. Preleptotene stage. Paired chromatic bodies are seen.
Fig. 2. Later stage of the same. Filaments run irregularly.
Fig. 3. Late leptotene stage, showing smooth chromatic filaments.
Fig. 4. Beginning of synizesis.
Fig. 5. Synizesis. Nucleus is considerably enlarged.
Fig. 6. Late stage of the same, showing spireme threads emerging from synizetic ball. Longitudinal pairing of threads is seen.
Fig. 7. Early pachynema. The longitudinal pairing of the threads is seen in places.
Fig. 8. Hollow spireme. Spireme thread exhibits an alternation of darker coloured areas with lighter ones.
Figs. 9a and 9b. Parts of the spireme thread, showing double nature of the thread.
Fig. 10. Late pachynema or early diplonema. The thread exhibits thick and thinner portions. Paired arrangement of threads is most marked.
Figs. 11 and 12. Diplonema. Segmentation begins at thinner portions of the spireme thread.
Figs. 13 and 14. Early strepsinema.
Fig. 15. Strepsinema. Segmented chromosomes appear like loops.
Figs. 16-18. Late strepsinema or early diakinesis, showing chain (Figs. 16 and 17) or ring complex (Fig. 18). The materials were fixed with BOUIN's fluid. Chromosomes appear somewhat thicker than those fixed with the other fixatives.
Fig. 19. Early diakinesis.
Fig. 20. Diakinesis. Some number of unpaired chromosomes are seen. Some chromosomes have a constriction in the middle, presenting dumb-bell shapes.
Fig. 21. Early metaphase, showing some unpaired chromosomes. Multipolar spindle is seen.

Fig. 22.   Metaphase. Two bivalent chromosomes are scattered out of the nuclear plate.

Fig. 23, a–d.   Bivalent chromosomes with constriction in different stages from early diakinesis to metaphase.

Fig. 24.   Meta-anaphase, showing a bivalent chromosome disjoining earlier than the other.

Fig. 25.   Late stage of the same.

Fig. 26.   Chromosomes in meta-anaphase showing their various shapes of disjoining.

Fig. 27.   Early anaphase. Longitudinal split of chromosomes is seen.

Fig. 28.   Anaphase. Two lagging chromosomes are seen left on the equatorial plane.

Fig. 29.   Telophase. Longitudinal split of chromosomes is marked.

Fig. 30.   Interkinesis. Split chromosomes are slenderer than in the preceding stage. Besides two ordinary nuclei, a micronucleus is seen.

Fig. 31.   The same, showing constriction of protoplast and rudimental cell plate.

Figs. 32 and 33.   Nuclei in interkinesis. Both longitudinal halves of a chromosome adhere at one portion, or are completely separated throughout their length. Fig. 33 represents a nucleus in a slightly later stage. Chromosomes are shorter and thicker than those in Fig. 32. Both are of polar view.

Fig. 34.   Two homeotype spindles orientated parallel to each each. Longitudinal halves of chromosomes are contracted and tightly associated together.

Fig. 35.   Metaphase of homeotype division. Two spindles lie at right angles to each other.

Fig. 36.   Anaphase of homeotype division. Chromosomes are slender and curved.

Fig. 37.   Telophase of homeotype division. Chromosomes are in contact with one another.

Fig. 38.   Tetrad. In each nuclei chromatic filaments run irregularly and many chromatic granules distribute between them.

Fig. 39.   Tetrad. Cell plates are seen between nuclei. There are one or two nucleoli in each nucleus.

Fig. 40.   Four pollen-grains.

PLATE XXXV
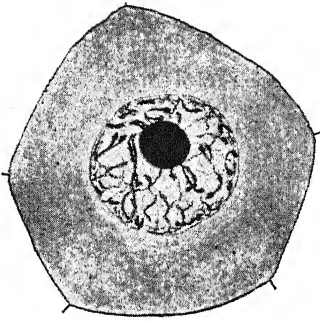


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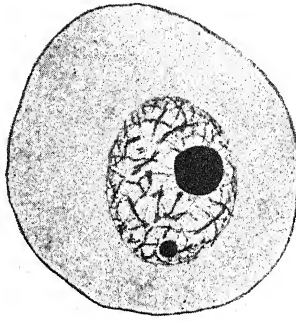
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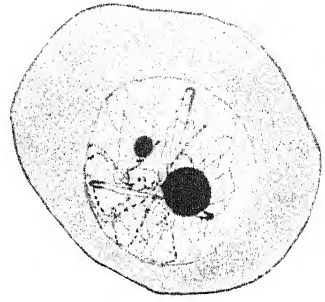
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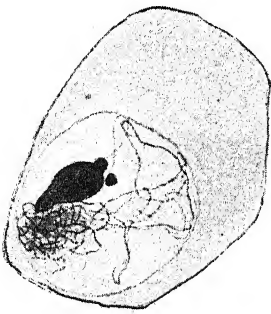
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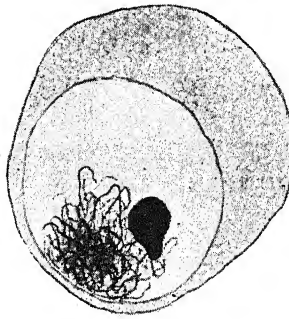
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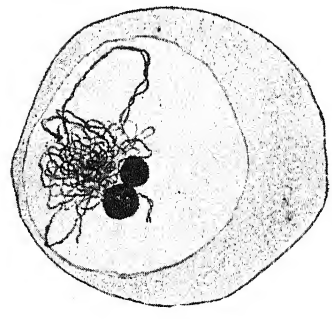
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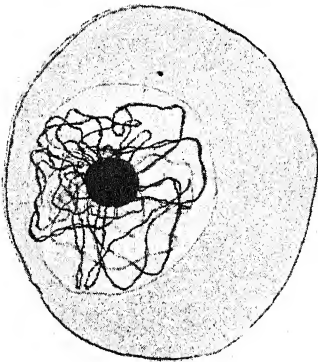
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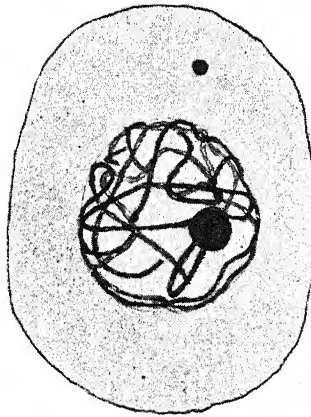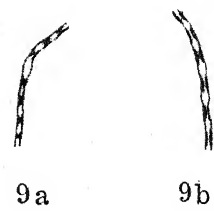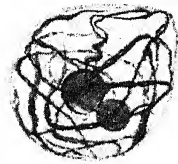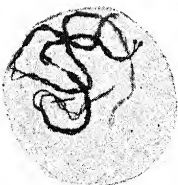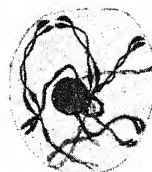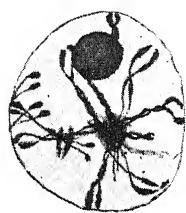
PLATE XXXVI



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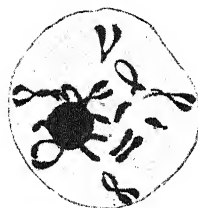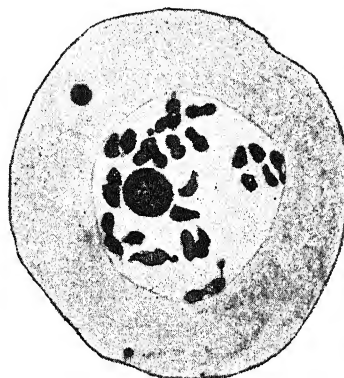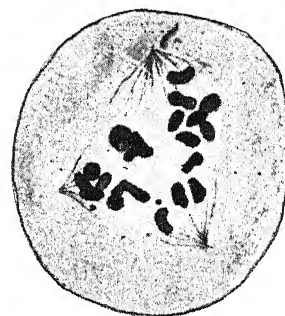
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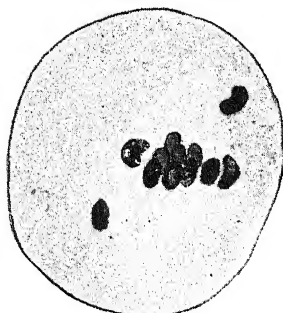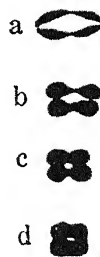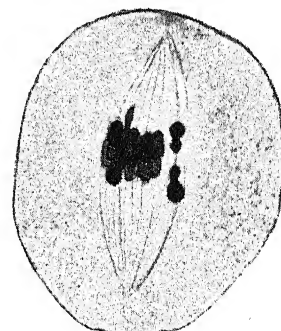
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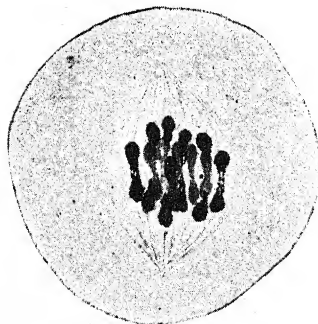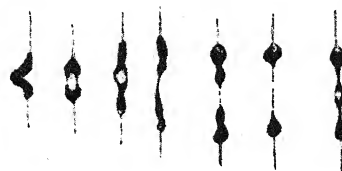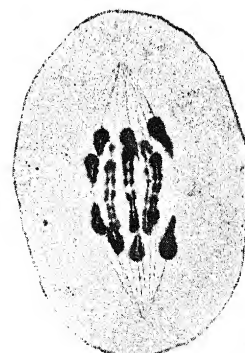
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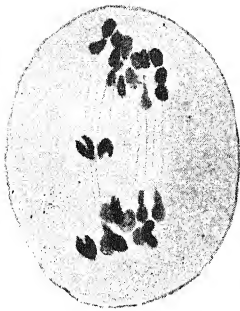
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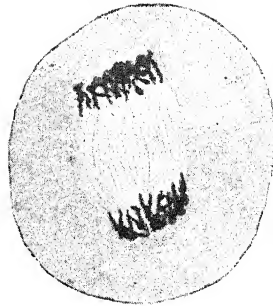
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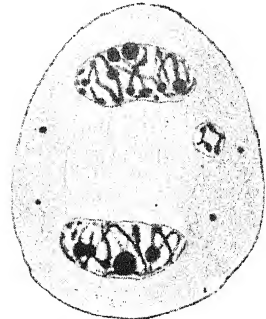
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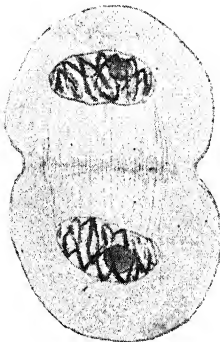
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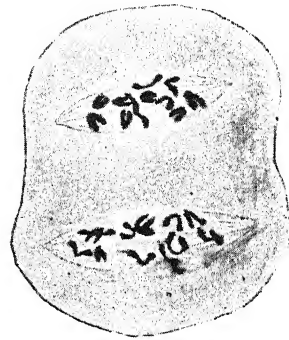
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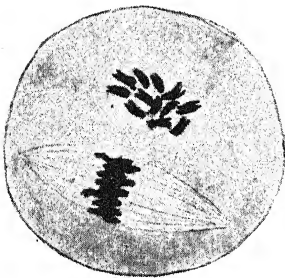
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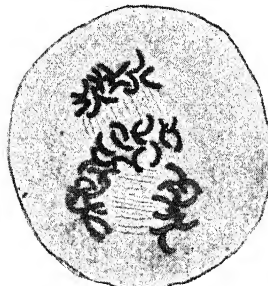
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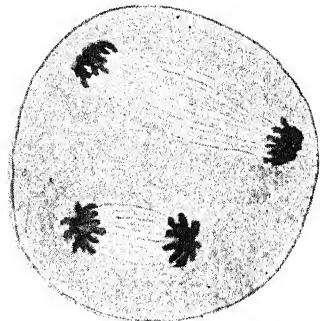
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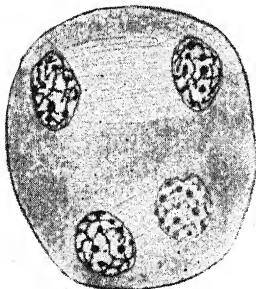
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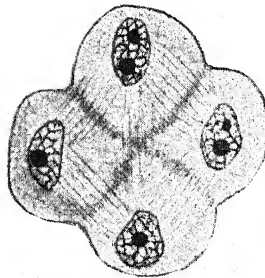
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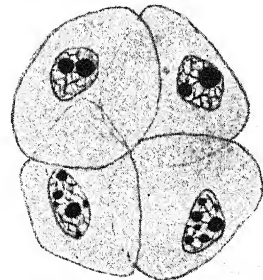
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# Abstracts Nos. 1–78

(Referring to the principal papers on Botany and related subjects which have appeared in Japan mostly during July-December 1927)

**1. Experimentelle Studien über die Pilzschaden von Reissämlingen IV.** (Japanisch). Takuzi ABE. (Jour. Plant Prot. **14**, 1927, 12 S.).

Das Verhalten der die Fäulnis der Reissämlingen verursachenden Pilze, *Achlya prolifera* und *Helminthosporium Oryzae* in reinem Wasserstoff wurde untersucht und es wurde gefunden, dass sie dort gut wachsen können, wenn auch später weniger üppig als die Kontrolle. Auch im vermittelst Pyrogallol O-frei gemachten Raume ist das Wachstum von *Achlya prolifera* ziemlich gut, wenn es ein wenig verhindert zu werden scheint, während dasselbe von *Helminthosporium, Hypochnus* und *Pestalozzia* darin ganz eingestellt ist. Dieser Unterschied dürfte verständlich sein, wenn man bedenkt, dass *Achlya* das Wasser bewohnt, d.h. den Ort, wo der freie Sauerstoff sehr gering vertreten ist. Auch die Tatsache, dass der O-Mangel als solcher, nicht aber die Druckabnahme, beim oben besprochenen Wachstum die Rolle spielt, wurde experimentell bewiesen.

*Achlya* kann nicht unter pH 4,0 wachsen, das Optimum liegt bei 6,2–7,2. Es scheint, dass der Pilz bis zu pH 8,4 ziemlich gut wachsen kann. Die Veränderung des pH-Wertes bei der Reinkultur in 1% Pepton wurde verfolgt und es wurde festgestellt, dass er sich allmählich nach der alkalischen Seite verändert.

**2. Pollen Abortion in the Shanghai Peach.** Yoshichirô ASAMI. (Jour. Sc. Agric. Soc. No. **297**, 1927, 364-372, 5 pls.).

The Shanghai peach is noted for its almost perfect self-sterility due to pollen abortion. The author has followed the pollen development of this peach as well as the Denjuro peach with normal pollen. The mode of development from the archesporium till the liberation of microspores is quite normal and identical in both. With the commencement of the latter process the difference sets in. In Denjuro peach, on one side, the microspore nucleus divides into two, and the cytoplasm grows rapidly, so that the pollen becomes completely filled with the latter. In Shanghai peach, however, though the grain walls increase their diameter there is almost no increase of cytoplasm, and the nucleus begins to disorganize before undergoing the division. The haploid number of chromosomes is 8 in both peaches.

**3. On a Phomopsis Disease of Japanese Pears.** (Japanese). Sigeru ENDÔ. (Jour. Plant Prot. **13**, 1927, 8 pp. and 1 pl.).—**II. Report.** (Ibid., 4 pp.).

In the Department of Tottori the culture of Japanese pears is much threatened by the invasion of a disease which infects stems and branches of trees and which however does not lead generally to their death. The susceptibility to disease is somewhat different in different strains. Trees which are older than ten years are more susceptible than younger ones. The disease is due to a new species of *Phomopsis, P. Fukushii* TANAKA et ENDÔ. The experiments on its culture, infection and control were performed.

Entries 1–3

**4. Further Studies on the Ever-segregating Race in Portulaca grandiflora L., with Special Reference to a Case of Triple Allelomorphism.** Nakae ENOMOTO. (Japan. Jour. Bot. **3**, 1927, 267–288).

**5. Ueber die Blattzellsaftkonzentration bei Reispflanzen.** (Japanisch). Nakae ENOMOTO. (Proc. Crop Sc. Soc. Japan No. **1**, 1927, 17-23).

Der Verf. hat die Zellsaftkonzentration der Blätter verschiedener Reissippen vermittelst der kryoskopischen Methode BECKMANNs studiert. Danach zeigt sie vor allem eine tägliche Periodizität, indem ihr Minimum um 6 Uhr Morgens und ihr Maximum um 3 Uhr Abends stattfindet. Je weiter die Pflanzenentwickelung fortgeht, desto höher wird die Saftkonzentration und die Differenz zwischen dem täglichen Maximum und Minimum ist zur Zeit des üppigsten Wachstums am grössten. Bezüglich des Einflusses der Aussenbedingungen wurde es konstatiert, dass die Saftkonzentration der Temperatur und dem Beleuchtungsdauer direkt und der Luftfeuchtigkeit umgekehrt proportional ist. Sie ist sowohl nach den Reissippen als auch nach den Düngungsmittelarten mehr oder weniger verschieden. Vergleicht man die am gewöhnlichen und am Sumpfboden kultivierten Reispflanzen zueinander, so erkennt man, dass die Saftkonzentration höher bei den ersteren als bei den letzteren ist.

**6. Untersuchungen über die Bestockung der Reispflanzen (Oryza sativa). I. Einfluss des Bewässerungs- und Beleuchtungsgrades auf die Bestockung, mit Berücksichtigung des Einflusses einiger anderer Faktoren.** (Japanisch mit deutsch. Zfg.). Sadayoshi FUKAKI. (Bult. Sc. Fak. Terk., Kjuŝu Imp. Univ. **2**, 1927, 337-365, 3 Textabbild.).

Die Bestockungsverhältnisse der hauptsächlich an den Töpfen gepflanzten Reispflanzen wurden unter verschiedenem Grade der Bewässerung und Beleuchtung untersucht. Bei den wassergesättigten Boden oder den mit seichtem Wasser bedeckten Töpfen ist der Bestockungsgrad der Pflanzen maximal, während bei Wassermangel oder bei zu tiefer Bedeckung mit Wasser der Vorgang mehr oder minder verhindert wird. Der Grad und die Geschwindigkeit der Bestockung werden bei schwacher Beleuchtung herabgesetzt.

Die Ernte vergrössert sich auch mit der Zunahme des Bestockungsgrades, doch nimmt die Zahl der ährenlosen Halme damit parallel zu.

**7. Cytological Studies on the Development of the Pollen-grain in Different Races of Solanum tuberosum L., with Special Reference to Sterility.** (With a Japanese résumé). Yasona FUKUDA. (Bot. Mag. Tôkyô **41**, 1927, 459-476, 42 text-figs.).

The cytological study of the author on 29 races of potato has shown him that in each the diploid number is 48. He has studied the cytology of pollen-formation in these potato races, and followed the processes which lead to the production of abnormal pollen, though in some races the development is quite normal and produces healthy grains. There are various kinds of abnormalities. In some cases the process goes on normally till the formation of tetrads which however undergo the disorganization. In others both hetero- and homotypic divisions are irregular, thus, for instance, the formation of small nuclei by some chromosomes lagging behind in the spindle, that of tri- or tetrapolar spindles which give rise to small or large super-

numerary nuclei. In others the two spindles of the homotypic division unite at one or both ends, producing a triad or dyad, or the reduction division and the longitudinal splitting of chromosomes take place simultaneously in the first division, giving rise to dyads also. In still others no homotypic division occurs, or the polyads are formed by the heterotypic division. In certain cases a multinucleate giant cell is formed, because the pollen mother-cell undergoes no cell-division, etc., etc. All processes above described lead to the formation of abortive pollen grains. The cause of pollen abortion is due according to the author primarily to the predisposition inherent to each race, and only secondarily to the influence of the environment.

**8. Genetic Studies of Leaf-characters in Morning Glories VI.** (Japanese with English résumé). Tokio HAGIWARA. (Bot. Mag. Tôkyô **41**, 1927, 648-664 with figs.).

Certain linkage groups of factors concerning flower-colour and leaf-character, etc. were found, and the crossover value between these factors was determined. Some other factors are also enunciated.

**9. On Monachosorella, a New Genus of Ferns.** (Japanese). Bunzô HAYATA. (Bot. Mag. Tôkyô **41**, 1927, 570-573, 3 figs.).

A Fern, to which the new name *Monachosorella Maximowiczii* is given by the author has been formerly placed among various genera by different authors, viz. *Ptilopteris*, *Phegopteris*, *Polystichum*, and *Monachosorum* (by the author himself). The difference between *Polystichum* and *Monachosorum* lies, firstly in the character of trichomes which are scaly in the former and few-celled in a single row in the latter, secondly in the structure of cells at leaf margin which are acute or spiny in the former and obtuse in the latter, and thirdly in the stele structure, being a dictyostele with no medullary strands of sclerotic cells in the former and apparently a transitional stage between the siphono- and the dictyostele with medullary strands in the latter. The Fern under discussion should belong to *Monachosorum* rather than to *Polystichum*, if we take the above facts into consideration. However, the author created for this Fern a new genus *Monachosorella* which is distinguished from *Monachosora* (*subdigitatum*) as follows: the latter is a Fern attaining several metres in length, characterized by bipinnately compound leaves and having sclerotic masses between meristeles and medullary strands of sclerotic cells, while the former is a small Fern with once pinnately compound leaves and lacking sclerotic masses. A Latin diagnosis of the new genus is given.

**10. On the Systematic Anatomy of Monachosorella Maximowiczii Hay., a Species representing a New Genus of the Polypodiaceae.** (Japanese). Bunzô HAYATA. (Bot. Mag. Tôkyô **41**, 1927, 642-648, 16 figs.).

The anatomical structure of rhizomes, stems, petioles, leaf-blades and roots is described in detail. The fundamental tissue of the stem consists of sclerenchyma and parenchyma with no fibrous cells at all, which distinguishes *Monachosorella* from *Monachosora*, because in the latter fibrous cells are found scattered everywhere in the fundamental tissue. The stele which is intermediate between siphonostele and dictyostele contains two or three meristeles, each of which belongs to the type of

concentric or more or less bicollateral bundle. The xylem is of exarch type. On account of descriptive character of the paper it is impossible to reproduce the details in this short abstract; for further details see the original paper.

**11. On the Systematic Importance of the Stelar System in the Filicales, I.** (Japanese). Bunzô HAYATA. (Bot. Mag. Tôkyô **41**, 1927, 697-718, 25 figs. in text).

Studies of forms and kinds of steles have hitherto been pursued on models made of paper or wax, sections, or on those taken out by certain macerating reagents. The author thinks that any of these methods gives no reliable results. He has studied the steles of various ferns by a new method which consists in directly separating and taking them out from the surrounding tissues by means of chisels and needles. He distinguishes four kinds of steles, viz. siphonosteles, dictyostelic siphonosteles, intermediate dictyosteles and dictyosteles proper. The author's careful studies refer to sixteen species of Japanese ferns. The results which are described in detail with illustrations are naturally impossible to be reproduced in this short abstract.

**12. Studies on Septorioses of Plants. I. Comparison of Two Different Species of Septoria Causing the Leaf-spot Diseases of the Cultivated Chrysanthemum.** Takewo HEMMI and Hisao NAKAMURA. (Mem. Coll. Agric., Kyoto Imp. Univ. No. **3**, Art. 1, 1927, 24 pp., 2 pls. and 4 figs.).

Two diseases of the cultivated *Chrysanthemum* are described. Black-spot disease hitherto known under the name of brown-spot or chrysanthemum blight is caused by *Septoria chrysanthemella* SACC., and brown-spot disease by *S. obesa* SYD.

The morphological and the cultural characters of both fungi are described in detail and compared. They may be distinguished from each other by the shape of spores which are filiform and uniformly wide in *Chrysanthemella* and whip-shaped and gradually attenuating towards the apex in *Obesa*. They also differ in thermal relations: the former grows at ca 32°C more vigorously than at 20°C, while in the latter no or very slight growth occurs at ca 32°C.

Inoculation experiments were performed.

**13. Contributions to the Knowledge of Anthracnoses of Plants. I. Notes on Three New or Little Known Anthracnoses of the Cultivated Plants in Japan.** Takewo HEMMI and Tomowo NOJIMA. (Mem. Coll. Agric., Kyoto Imp. Univ. No. **3**, Art. 2, 1927, 39 pp. and 1 pl. and 2 figs.).

1. Onion smudge caused by *Colletotrichum circinans* (BERK.) VOGLINO, a well-known disease in America and Europe, was discovered recently in Japan. The authors have studied its morphological characters which agree with the description of several American and European pathologists. Pure cultures are easily obtainable and its pathogenicity to the bulb-scales of onion has been proved experimentally.

2. A new anthracnose which attacks the leaves of *Aucuba japonica* was formerly reported by HEMMI to be identical to *Colletotrichum Pollaccii* MAGNAGHI. The authors made the minute studies of the morphological characters of this fungus and this has confirmed the fact that it must be considered as a species of *Colletotrichum*. It is however remarkable that any species of *Colletotrichum* or *Gloeosporium*

hitherto recognized (incl. *C. Pollaccii* MAGNAGHI) has never produced conidia as large as in the present fungus. Chiefly owing to this reason, and besides since *Colletotrichum* is often included in the genus *Gloeosporium*, the authors consider the present fungus to be a new species, *Gloeosporium (Colletotrichum) kiotoense* HEMMI et NOJIMA. The Latin diagnosis is given.

3. A *Gloeosporium* fungus causing the poppy anthracnose was formerly studied by HEMMI; it occurs on the ovaries, the mature fruits and the stalks. Inoculation experiments were done, either by introducing spores into living fruits through punctures made by sterilized needle, or by liberally spraying the surface of plants by means of atomizer with spores suspended in sterilized water. These experiments have proven firstly that this *Gloeosporium* on poppy fruit is pathogenic, not only to this plant itself, but also to apples and grapes, causing the typical bitter-rot, and secondly that inversely the causal organism of the bitter-rot of apples and also of the anthracnose of figs causes a *Gloeosporium* disease of poppy exactly similar to that just mentioned, so that the identity of all these pathogenic organisms has been proven. It is however well known that in *Gloeosporium* there are several strains which are morphologically quite similar and yet physiologically distinct. The organisms under discussion may be physiologicaly distinct races, and the fungus from the poppy may be identical with the chromogenic form described by SHEAR and WOOD.

**14. Studies on Sclerotium Diseases of the Rice Plants I.** (Japanese with English résumé). Takewo HEMMI and Kuniomi YOKOGI. (Agric. and Hortic. **2**, 1927, 955-1094, 1 pl.).

The paper is concerned with the description of the effect of temperature on the mycelial growth as well as the sclerotia formation of *Hypochnus Sasakii* SHIRAI, *H. centrifugus* (LÉV.) TUL., *Sclerotium Oryzae-sativae* SAWADA and an undetermined species of *Sclerotium* parasitic on the rice plants.

Little or no growth occurs at about 10°C. A slight growth occurs at 40°C, and the maximum temperature lies between about 40°–42°C. The thermal effect on the mycelial growth is however somewhat different according to the media in which the fungi are growing. Thus, for example on the apricot decoction agar they have a narrower limit of the growth than on other media. The optimum temperature is about 30°C for *H. Sasakii* and *centrifugus*, 32°C for *S. Oryzae-sativae*, and 28°C for the undetermined species of *Sclerotium*.

**15. Ueber die Chromosomenzahl bei einigen Allium-Arten.** (Japanisch mit deutsch. Zfg.). Kenji HIRATA und Kôzô AKIHAMA. (Bot. Mag. Tôkyô **41**, 1927, 597-600, 11 Textabbild.)

In einer gelegentlich ausgeführten Untersuchung der Chromosomenzahl von zehn verschiedenen Arten der Gattung *Allium* wurde bei acht Arten die Haploidzahl 8 bestimmt, dagegen bei anderen zwei, *Allium victorialis* (gesammelt in Hokkaidô) und *A. Middendorfianum* 16, woraus ersichtlich ist, dass eine Tetraploidie auch bei der Gattung *Allium* bestätigt werden kann.

K. MIYAKE (1906) hat in seiner Arbeit über Pollenmutterzellen von *A. victorialis*, dessen Material in Europa gesammelt wurde, 8 als die Haploidzahl angegeben, welche in unserem Falle nicht gültig ist.

Aus dieser Tatsche geht es hervor, dass unser Material eine andere Form als diejenigen, die von MIYAKE untersucht wurde, darstellen dürfte.          Verf. n.

**16. Beiträge zu einer Monographie der Gattung Pucciniastrum Otth.** Naohide HIRATSUKA. (Jour. Facult. Agric. Hokkaidô Imp. Univ. **21**, 1927, 63-119, 1 pl.).

Seitdem i. J. 1861 die Gattung *Pucciniastrum* mit der dazu gehörigen Art *P. Epilobii* von OTTH neu aufgestellt worden ist, ist die Anzahl der dazu hinzukommenden Arten allmählich angewachsen, sodass man jetzt deren 22 kennt.   In dem vorliegenden Aufsatze sind alle diese Arten hervorgehoben mit Synonymen, Literaturangaben usw. und beschrieben.   Diese Arten sind:  *P. Miyabeanum* HIRATSUKA, *P. Styracinum* HIRATSUKA, *P. Pyrolae* (KARST.) SCHRÖTER, *P. Kusanoi* DIETEL, *P. Circaeae* (THÜM.) SPEGAZZINI, *P. Epilobii* OTTH, *P. Tiliae* MIYABE, *P. Coriariae* DIETEL, *P. Agrimoniae* (DIET.) TRANZSCHEL, *P. americanum* (FARL.) ARTHUR, *P. arcticum* TRANZSCHEL, *P. Potentillae* KOMAROV, *P. Hydrangae-petiolaridis* HIRATSUKA, *P. Boehmeriae* SYDOW, *P. Castaneae* SYDOW, *P. Coryli* KOMAROV, *P. Fuchsiae* nov. comb., *P. Wickstroemiae* ARTHUR, *P. Celastri* SYDOW, *P. Goodyerae* ARTHUR.

**17. A Contribution to the Knowledge of the Melampsoraceae of Hokkaidô.** Naohide HIRATSUKA.   (Japan. Jour. Bot. **3**, 1927, 289-322).

**18. A Canker Disease of Prunus Mume and P. persica Caused by a Species of Camarosporium.** (With a Japanese résumé).   Yasu HOMMA.   (Bot. Mag. Tôkyô **41**, 1927, 541-546).

In the vicinity of Sapporo (in Northern Japan) *Prunus Mume* and *persica* are attacked by a canker disease due to *Camarosporium persicae* MAUBL., which is very serious, especially to the seedlings of the former tree.   The infection experiments have shown that the fungus is able to attack the trees, only when there are wounds in their bark.   The culture on various media has been done, and it was observed that the growth thereon is very slow.

**19. Revisio Graminum Japoniæ. XIV.** Masaji HONDA.   (Bot. Mag. Tôkyô **41**, 1927, 635-641).

In this paper the following items are contained.

1.   6 new species and 5 new varieties :
     *Calamagrostis Yendoana* HONDA (from Kurile)
     *Trisetum formosanum* HONDA (from Formosa)
     *Perotis macrantha* HONDA (from Formosa)
     *Arundinella paniciformis* HONDA (from Corea)
     *Arundinella oleagina* HONDA (from Hondo)
     *Poa milioides* HONDA (from Formosa)
     *Calamagrostis Matsumurae* var. *aristata* HONDA (from Yezo)
     *Deschampsia caespitosa* var. *festucaefolia* HONDA (from Kiusiu)
     *Eleusine indica* var. *oligostachya* HONDA (from Formosa)
     *Poa acroleuca* var. *spiciformis* HONDA (from Hondo and Kiusiu)
     *Poa sphondylodes* var. *Koidzumi* HONDA (from Hondo).

2. The commonly used name *Centotheca lappacea* DESVAUX is to be changed to *Centotheca malabarica* MERRILL, and *Centotheca lappacea* var. *inermis* RENDLE is to be naturally combined as *Centotheca malabarica* var. *inermis* HONDA.

3. *Arundinella anomala* var. *hirtiglumis* HACKEL, *Poa misera* var. *alpina* KOIDZUMI and *Poa macrocalyx* var. *sachalinensis* KOIDZUMI are to be changed to *Arundinella hirta* var. *hirtiglumis* HONDA, *Poa sphondylodes* var. *alpina* HONDA and *Poa sachalinensis* HONDA respectively.                    Author.

**20.  The Genetics of Pharbitis purpurea.** Yoshitaka IMAI. (Jour. Coll. Agric. Imp. Univ. Tôkyô **9**, 1927, 199-222, 1 table and 1 pl.).

The three types of stem color, colored, intensely colored and green are due to different combinations of two allelomorphic pairs **S, s** and **R, r** which are also concerned in the determination of the flower-color, though for the color of corolla two other factor pairs, **U, u** and **D, d** intervene also.  The factors **s** and **d** are linked. Feathered double behaves dominant to the single.  Between flower color and doubleness there is no linkage.  Tan seed is recessive to the black and both these characters are due to the action of **S, s** factors.

**21.  The Vegetative and Seminal. Variations Observed in the Japanese Morning Glory, with Special Reference to Its Evolution under Cultivation.** (Jour. Coll. Agric., Imp. Univ. Tôkyô **9**, 1927, 223-274, 4 pls. and 25 text-figs.).

During the culture of the Japanese Morning Glory the author could discover a number of mutants which were produced either massively or singly.  The massive appearance of mutants occurred according to the simple recessive ratio in the $F_3$ pedigrees of certain crossings, the parents of which should accordingly have been derived from the union of normal and mutated gametes.  The single mutant seems, on the contrary, to have been produced by double mutations occurring in pairing allelomorphs at fertilization, so as to produce a recessive homozygote among homozygous sisters.  Habitual mutability of the so-called ever-sporting races which takes place in both gameto- and somatogenesis proved to be heterozygous.  All cases of vegetative mutation observed by the present author is that recessive → dominant.

Basing on the experience got during his culture of this plant the author concludes that its evolution is mainly due to sporadic mutations, and almost always to recessive mutation from the prototype.  As the habitual mutation which is from recessive to dominant is the process of reverting to the prototype factor, it has almost nothing to do with its evolution.

**22.  The Right- and Left-Handedness of Phyllotaxy.** Yoshitaka IMAI. (Bot. Mag. Tôkyô **41**, 1927, 592-596).

In the phyllotaxy of the Japanese Morning Glory the left- and the right-handedness are equally frequent.  The alternate condition is not heritable, nor is the direction of phyllotaxy invariable in one and the same individual.

**23.  Discovery of Podostemonaceae in Japan.** Shun-ichiro IMAMURA. (Proc. Imp. Acad. **3**, 1927, 616-618, 3 figs.).

One plant belonging to the Podostemonaceae was recently found in Southern Japan. The plant looking like a liverwort creeps upon the surface of tuff beds and andesite stones which are submerged under water. The plant consists of a green thallus-like root with tufts of short, slender leaves upon it. The flower, enclosed in a spathe, has one zygomorphous pistil and one stamen. As flowers are submerged under water, cleistogamy seems to be the usual mode of fertilization.

### 24. Studies in the Inheritance of Sterility in Rice. Junichi ISHIKAWA. (Jour. Coll. Agric., Hokkaido Imp. Univ. **20**, 1927, 79–201, 4 pls.).

The experiments described in this paper are concerned with the inheritance of rice-plants of various degrees of sterility. The "sterile plant" of the writer is that which produces in average $\pm 80\%$ sterile spikelets. The sterility is due to the complete abortion of pollen, the embryo-sacs being always quite healthy, hence the production of fertile spikelets thereon is due exclusively to the natural crossing by pollen derived from homo- or heterozygous fertile plants. The latter fact explains why the sterile plant is characterized by always throwing besides fertiles a small number of sterile plants, because it is a monohybrid recessive and should necessarily undergo the crossing by fertiles in order to produce viable seeds. Kernels with neither embryo nor endosperm are produced without fertilization.

The plant bearing about $40\%$ sterile spikelets is called "partial-sterile." It throws both fertile and sterile offspring. The former breed true already in the next generation, while the latter always throw $\pm 12\%$ partial-steriles, i.e. nearly 7 fertiles and 1 sterile. The ovules of partial-steriles are quite normal in their development and the germination of pollen was found to be as good as that from the fertiles. The cross between fertiles segregated out from partial-steriles among each other as well as that partial-sterile ♀ ×fertile ♂ give the $F_1$ plants which are fertile without exception. Seeds of partial-sterile are able to germinate quite well. The partial sterility is explained by the hypothesis that it is a monohybrid **Ss,** where the female gamete **S** only (not **s**) is functional and the functional pollen grains are in the ratio of 7 **S** : 1**s.**

The rice-plant, in which the sterile spikelets amount to $\pm 50\%$ is called "semi-sterile." It has first arisen from a family which has split in the ratio of 1 fertile and 1 sterile offspring. The semi-steriles thus arisen segregated then in the same manner as in the previous year, while the fertiles bred true. The semi-sterile plant may be represented as **AaBb.** Of four kinds of gametes, either male or female, which should be derived from it only **Ab** and **aB** are functional, **AB** and **ab** being abortive, so that the zygotes **AAbb,** 2**AaBb** and **aaBB** are produced; of those the first and the third are fertile and breed true, while the second is semi-sterile and segregates again. This hypothesis is supported by the observation that half of the ovules and pollen are really abortive; this explains the facts that the fertile and the sterile offspring which are segregated out and also the fertile and the sterile spikelets on each semi-sterile plant are equal in number.

### 25. On the Budding of Nucleoli in the Root-nodule of Wistaria. Tadao JIMBO. (Bot. Mag. Tôkyô **41**, 1927, 551–553, with figs.).

In the root-nodule of *Wistaria floribunda* the nucleolus of almost every cell shows a spherical bud. In the bacterial cell two or three buds are sometimes found in one

nucleolus, which are observed not only on its surface, but also lie freely inside the nucleus. In the hypertrophied bacterial cell where the nucleus is also hypertrophied the nucleolus and its bud are correspondingly large. No nucleolar budding is observed in the cell of root-tip. In some other species and varieties of *Wistaria* a similar nucleolar budding is seen in the heterotypic division.

**26. An Instance of Radish-Cabbage Hybrids.** Yôiti KAKIZAKI. (Jour. Sc. Agric. Soc. No. **298**, 1927, 438–446, 4 figs.).

Intergeneric reciprocal crossings between radish and cabbage were done. Only the cross where the former is female gave a few seeds which required a very long time for germination and gave rise to weak seedlings. Only two adult hybrids were got. At first they were much worse in vigour than either parent, though afterwards they became very vigorous. As to the external characters they were generally intermediate between the two parents. Thus, for instance, though they did not form any heart, but rosettes as in radish, yet young inner leaves had some tendency of turning inwards. Some roots are either more or less thick as in radish, while others are thin and short as in cabbage. Early leaves resembled the cabbage in shape, but later leaves were similar to those of the radish. In thickness and colour leaves are also intermediate. Flowers are white with a faint purple shade, sometimes with supernumerary petals and stamens. Pollen was irregular and variable in shape and size. One ripe pod was obtained, of which the lower and the upper part resemble the pod of cabbage and radish respectively. Hybrids were sterile.

**27. Albino and Deficient Seedlings of Balsam.** Bensô KANNA. (Bot. Mag. Tôkyô **41**, 1927, 547–551).

In the F₃ progeny of certain crosses made between different strains of *Impatiens Balsamina* albino as well as deficient (concerning cotyledons, hypocotyls, leaves or stems) seedlings were segregated out as monohybrid recessives. The phenomenon may be due to the mutation in the previous generation.

**28. Vergleichende Studien über die zytologischen Veränderungen in den Wurzelspitzen der durch Kohlenteer bezw. Röntgenstrahlen behandelten Pflanzen.** Hideo KOMURO. (Proc. Imp. Acad. **3**, 1927, 445–448, 16 Textabbild.).

Früher hat der Verf. in den durch die X-Strahlen behandelten Wurzeln einiger Pflanzen, besonders *Vicia faba* die sog. RÖNTGENgeschwülst entstehen lassen, wobei er ausführlich das zytologische Verhalten verfolgt hat. Der Verf. hat diesmal die Pflanzenwurzeln mit Kohlenteer wiederholt bestrichen; bekanntlich haben YAMAGIWA und ITCHIKAWA durch die gleiche Behandlungsweise im Innern der Kaninchenohren Tumoren entstehen lassen. Der Verf. hat bei solchen Pflanzenwurzeln die abnormalen zytologischen Veränderungen verfolgt und in einem tabellarischen Uebersicht die Ähnlichkeiten und Unterschieden des zytologischen Verhaltens in den in beiden Weisen behandelten Pflanzenwurzeln gezeigt. Die Degenerationsstufen der mit Kohlenteer behandelten Materialien sind auch tabellarisch erläutert.

**29. Ueber die in der Landwirtschaft Japans gebrauchten Samen. (Sechste Mitteilung).** Mantarô KONDÔ. (Ber. d. Ôhara-Inst. f. Landw. Forsch. Kuraschiki, **3**, 1927, 441-455).

In dieser Abhandlung wurden die Samen von *Corchorus capsularis, Boehmeria nivea, Kochia scoparia*, und *Tetragonia expansa* untersucht. Der Verfasser hat stets die äusseren Merkmale und den anatomischen Bau der Samen eingehend untersucht und noch die Beschaffenheiten der Keimpflanzen beobachtet. Autoref.

**30. Spontane Entstehung einer missgestalteten Reispflanze "Magatamaine."** Mantarô KONDO und Sumita FUJIMOTO. (Ber. Ôhara-Inst. f. landw. Forsch. **3**, 1927, 421-424, mit 2 Tafeln).

Im Jahre 1919 kam ein missgestaltete Reispflanze unter den gewöhnlichen Pflanzen von "Shinriki" spontan zum Vorschein. Ihre Rispen sowohl wie die Körner weisen eine merkwürdige Missgestaltung auf. Diese neu entstehende Pflanze haben die Verfasser "Magatamaine" genannt. Die Rispen sind schmäler, aber länger als bei "Shinriki." In der Vollreifezeit hängen die Rispen nicht herunter. Auch stehen die Zweige der Rispen aufrecht. Das bespelzte Korn ist grau gefärbt, abgeplattet, in der Flächenansicht schmal, spindelförmig, aber etwas gekrümmt. Das enthülste Korn ist schmutzig gefärbt, am Griffelende schmäler und kegelförmig. „Magatamaine" ist ganz konstant. Das characteristische Merkmal von "Magatamaine" ist zum Merkmale von „Shinriki" hin rezessiv. Die erbliche Beziehung beider Eigenschaften folgt nach dem MENDELschen Gesetz von Monohybrid. Unter den Nachkommen von Fertilpflanzen von „Magatamaine" kommen oft Semisterilpflanzen zum Vorschein. Autoref.

**31. Untersuchungen der verschiedenen Reiskörner geringerer Qualität I. Die braun gefärbten enthülsten Reiskörner "Tschamai."** Mantarô KONDO und Tamotsu OKAMURA. (Ber. Ôhara-Inst. landw. Forsch. **3**, 1927, 405-419, mit 1 Tafel). Siehe Jap. Jour. Bot. **3**, 1927, (56), Abstract Nr. 161.

**32. Vergleichende Untersuchungen der physikalischen Eigenschaften des enthülsten (Genmai) und des bespelzten Reiskornes (Momimai). I. Vergleich der Hygroskopizität des enthülsten, des bespelzten Reiskornes und der Spelze.** (Japanisch m. deutsch. Zfg.) (Jour. Sc. Agric. Soc. No. **297**, 1927, 341-363). Mantarô KONDÔ und Tamotsu OKAMURA.

Es ist wohl bekannt, dass während der Aufbewahrungszeit des Reises das enthülste Reiskorn sehr leicht und schnell Schaden leidet, das bespelzte Reiskorn hingegen sehr gut aufbewahrt werden kann. Der Unterschied in dem Verhalten muss verschiedene Ursache haben. In dieser Abhandlung wird der Unterschied der Hygroskopizität des enthülsten, des bespelzten Reiskornes und der Spelze untersucht.

Als Versuchsobjekte benutzte man zwei Reissorten und zwar „Shinriki" und „Omachi." Der Versuch wurde in der Zeit von 1924 bis 1927 durchgeführt und drei Mal wiederholt.

Die Proben des enthülsten und bespelzten Reiskornes und der Spelze wurden am Anfang des Versuches genau gewogen und in feuchter Luft aufbewahrt. Jeden Tag oder alle zwei Tage wurden sie gewogen und ihre Gewichtszunahme ermittelt. Der Wassergehalt der Versuchsobjekte wurde am Anfang des Versuches bestimmt, während des Versuches aber ist er durch Rechnung festgestellt worden.

Die Ergebnisse waren folgende :

1). Die Gewichtszunahme des enthülsten Reiskornes und bespelzten Kornes, die auf Hygroskopizität beruht, waren gleich; die Gewichtszunahme der Spelze durch Hygroskopizität war aber viel geringer und ging langsamer vor sich. Wenn aber die Proben am Anfang des Versuches in geheiztem Raum so ausgetrocknet wurden, bis sie wasserfrei waren, war ihre Gewichtszunahme durch Hygroskopizität beim enthülsten Reiskorn grösser und ging schneller vor sich, als beim bespelzten, weil seine Oberfläche gesprungen war.

2). Der Wassergehalt der Proben ist bei dem enthülsten Korn am grössten, beim bespelzten Korn etwas geringer und beim Spelz am geringsten. In feuchter Luft nimmt der Wassergehalt der Proben allmählich zu. Wenn man den Wassergehalt jeder Probe zu Anfang als 100 annimmt, und den Wassergehalt während der Aufbewahrungszeit berechnet, dann bemerkt man, die Zunahme des Wassergehaltes beim bespelzten Korn am grössten, beim enthülsten etwas geringer, beim Spelze am geringsten ist.

3). Es hat den Anschein, als ob die Spelze die Hygroskopizität des bespelzten Kornes hindere, weil die Hygroskopizität der Spelzen selbst gering ist. Dies ist aber nicht der Fall. Die Hygroskopizität des bespelzten und des enthülsten Kornes ist gleich. Das Vorhandensein der Spelze um das Korn hindert also nicht die Hygroskopizität des Kornes. Autoref.

### 33. Colour Inheritance of Glume-tips and Stem-nodes in Certain Paddy Rice-plants. I. (Japanese). Tai Chong LEE (Ann. of the Agric. Exp. Station Korea, No. 12, 1927, 367-371).

Of the strains of paddy rice-plants, Wase, Bungo and Hinode characterised by pale yellowish glume-tips the cross Wase × Bungo as well as Wase × Hinode were done: the $F_1$ plants have purple glume-tips, and in $F_2$ the segregation takes place according to the ratio purple : red : pale yellow = 27 : 9 : 28. The explanation is as follows. Wase = **CCrrbb**, Hinode or Bungo = **ccRRBB**, consequently $F_1$ a trihybrid **CcRrBb**, in which **CRB** produces purple colour, **CRb** red, and **CrB** has no colour effect.

The cross of Wase with purple stem-nodes by Hinode or Bungo, either of which has green nodes, produces $F_1$ plants with purple nodes, and in $F_2$ we have purple : green = 27 : 37. The explanation is easy: Wase = **AARRBB**, Hinode or Bungo = **aarrbb**, $F_1$ = **AaRrBb**, where **ARB** only produces purple colour, and neither **AR** nor **AB** has colour effect.

When the characters of both glume-tips and nodes are considered simultaneously, $F_1$ may be a tetrahybrid represented by **AaBbCcRr**, where the factors **B** and **C** for glume-tips are identical with those for stem-nodes. The $F_2$-segregation into five phaenotypic kinds of offspring in the theoretical ratio 81 : 27 : 27 : 36 : 85 was nearly realised, and proves consequently the rightness of the above supposition; it was further confirmed by the results of the $F_3$-generation.

### 34. Ueber die Reissamenkeimung in verschiedenen Salzlösungen. (Japanisch). Disuke MASUBUTI. (Proc. Crop Sc. Soc. No. 1, 1927, 42-51).

Nachdem die Reissamen während 20 Tagen in den Lösungen verschiedener Salzen (schwefelsaures Ammonium, schwefelsaures Magnesium, schwefelsaures Kalium,

chlorsaures Natrium) eingetaucht worden sind, sind sie gesät. Die Samen werden dabei mehr oder weniger beschädigt, womit das Keimungsprozent erniedrigt und die Keimung verspätet wird. Wenn man die aequimolaren Salzlösungen gebraucht, ist das Keimungsprozent fast dasselbe bei allen obengenannten Salzen, und je höher die Salzkonzentration ist, desto mehr wird die Keimung verzögert. Wenn man die in den Salzlösungen eingetauchten Samen im gewöhnlichen Wasser übertragen und dann sie säen wird, so sieht man, dass das Keimungsprozent nach der Konzentration der gebrauchten Salzlösungen verschieden ist: je konzentrierter sie sind, desto leichter die Beschädigung der Samen und dementsprechend desto grösser das Keimungsprozent ist. Alle oben angedeuteten Tatsache dürften auf Grunde der Semipermeabilität der Samenschale leicht erklärbar sein: je konzentrierter die Salzlösung ist, desto schwieriger muss die Wasserabsorption durch die Samen sein, woher die Verspätung der Keimung, auch je konzentrierter die Salzlösung ist, desto schwieriger muss das Durchdringen der Salzen im Innere Samens sein, woher die leichtere Beschädigung der Samen und das grössere Keimungsprozent. Die Keimung der Samen von verschiedenen Reissippen in Natriumchloridlösungen verschiedener Konzentration wurde besonders eingehend untersucht.

**35. A Study of the Ectotrophic Mycorrhizas of Woody Plants.** Kôki MASUI. (Mem. Coll. Sc., Kyoto Imp. Univ. Ser. B. **3**, 1927, Art. 2, 149-279, 5 pls. and 93 figs.)

The author has discovered a number of mycorrhizal fungi chiefly on *Pinus densiflora*, viz. *Armillaria caligata*, *A. Matsudake*, 4 species of *Cortinarius*, *Cantharellus floccosus*, *Hydnum affine*, *Polyporus leucomelas* and *Scleroderma vulgare* (?). About each of them the mode of development of mycorrhiza and the formation of fruiting bodies were studied in detail. Microchemical investigations were performed, chiefly to elucidate the nutritive relation between the host and the fungi.

The mycorrhizas of woody plants may be classified into ectotrophic, heterotrophic and ecto-endotrophic ones. Those belonging to the second and the third class are provided with both extra- and intracellular hyphae, and these two classes may be distinguished from each other by the fact that intracellular hyphae are ultimately digested in the latter, while in the former not. The fruiting bodies are formed in various ways: in some they are developed either directly on an infected root or on the mycelium interwoven by the hyphae projected from numerous mycorrhizas which have no connection with humus, while in others they are developed on some hyphal bundles projected from the mycorrhizas which are connected with humus or even directly on humus itself. Pure cultures of mycorrhizal fungi on certain artificial nutrient media were performed mostly with success, and the synthetic experiment of the mycorrhiza formation on *Pinus densiflora*, *P. Thunbergii*, etc. with these pure cultures has given positive results in certain cases. The mycorrhizas studied by the author are either obligate or facultative. In the former, for instance, *Armillaria*, *Cortinarius*, *Hydnum* and *Polyporus*, mycorrhiza are actually connected with living roots of the hosts, and the fruiting bodies formed chiefly at the expense of the latter. Microchemical studies have shown that they suck up amino-acids and sugar from the growing point of the root, but supply no essential salts to it. There is no evidence that the roots of hosts are benefited by association with such fungi. Such mycorrhizas may be considered to be a case of the true parasitism of fungi on the roots of vascular

plants. On the other hand, in facultative mycorrhizas, as *Boletus*, the fungus supplies a certain amount of phosphorus and other salts to the host, while the roots of the latter digest intracellular hyphae and give benefit to the fungus. But since even in this case the latter deprives amino-acids and sugar from the roots of host and finally leads to their death, such mycorrhizas are called " semisymbionts."

**36. Ueber den Verzweigungsmodus und die Blattanordnung des Rhizoms von Nelumbo nucifera, Gärtn.** (Japanisch m. deutsch. Zfg.). Shigeru MIKI. (Bot. Mag. Tôkyô **41**, 1927, 522-526, 1 Taf. und 4 Textabbild.).

Das Rhizom von *Nelumbo nucifera*, GAERTN. ist ein Sympodium. Die Hauptachse endet nämlich stets auf einem Blütenstande oder einer Spur desselben. Die Achselknospe des ersten Niederblattes macht das nähste Internodium des Rhizoms aus, und das zweite Niederblatt stellt das Vorblatt des Blütenstandes dar.

Die Achselknospe des Laubblattes entwickelt sich als Seitenzweige des Rhizoms. Die Anordnung der Blätter in der Achselknospe des Laubblattes ist anders als es von WIGAND und DENNERT behauptet wurde. stets regelmässig : d. h. ein adossiertes Vorblatt und zwei Niederblätter stehen sukzessiv alternierend, und das nähstfolgende Laubblatt steht in der nämlichen Seite des zweiten Niederblattes.          Autor.

**37. Icones of the Essential Forest Trees of Hokkaidô.** Kingo MIYABE and Yushun KUDO. **2**, Fasc. 11-18, 1925-1927. Publ. by the Hokkaido Government, 24 colored pls. with Japanese and English explanations.

The following plants are contained : *Fagus Sieboldi, Castanea crenata, Quercus dentata, Q, mongolica, Q. crispula, Q. glandulifera, Ulmus japonica, U. laciniata, Celtis Bungeana* var. *jessoensis, Morus bombycis, Cercidiphyllum japonicum, Magnolia obovata, M. Kobus* var. *borealis, Hydrangea paniculata, Malus baccata* var. *mandshurica, Sorbus commixta, Micromeles alnifolia, Photinia villosa, Crataegus jozana, Prunus Maximowiczii, P. Sargentii, P. kurilensis, P. Padus.*

**38. Genetic Studies on Papaver somniferum.** Kiichi MIYAKE and Yoshitaka IMAI. (Jour. Coll. Agric. Imp. Univ. Tôkyô **9**, 1927, 275-332, 3 pls. and 11 textfigs.).

Flower is either white or colored with white or purple centre, which is due to the action of five allelomorphic pairs of factors in various combinations. White is either dominant or recessive. For further information s. Japan. Jour .Bot. **3**, 1927, (95), No. 283.

**39. Vegetation and Natural Monuments of the Hawaian Islands.** (Japanese). Manabu MIYOSHI. (Tôkyô, 1927, publ. by Home Dept. of Japan, 38 pp. and 11 textfigs.).

The paper contains chiefly what the author has observed in the Hawaian Isl. during his travel in April 1927.

The plant zone is classified into four according to HILLEBRAND. In that of seashore and plains the plants are generally those which were introduced or naturalized. The forest zone on mountain foot at 1000-2000 feet level contains either hydrophilous or xerophilous plants, the most abundant of the latter being *Gleichenia linearis* and

*glauca.* In this zone large trees are rare, though *Acacia Koa* which is most commonly met with may attain comparatively large size. In the forest zone on mountain side at the ± 4000 feet level *Metrosideros collina* subsp. *polymorpha* var. *typica* is most remarkable. This zone abounds in tree-ferns. In the zone of high mountain at 6000-9000 feet level the plants are growing very sparingly, and only few small trees and ligneous herbs are met with.

Higher plants already known in the Hawaian Isl. amount to 1000 species, of which 85% are indigenous. It is remarkable that the Coniferae, Equisetaceae and the Rhizophoraceae are entirely wanting.

Introduced plants include palms, cycads, *Eucalyptus* and various others. Naturalized plants include *Batis maritima, Pluchea indica, Lantana Camara, Opuntia Tuna*, etc., etc.

One of the very interesting facts observed is the regeneration of plants on the place where they had been entirely destroyed by lava flow. The lower Cryptogams begin to appear at first, then come the herbaceous ferns which are followed by the tree-ferns, such as *Cibotium Menziesii*. Among the trees *Metrosideros* above mentioned is one which appears first.

The author discusses the problem of preservation of natural monuments in the Hawaian Isl.

**40. Notulae ad Plantas Japoniae & Koreae XXXIV.** Takenoshin NAKAI. (Bot. Mag. Tôkyô **41**, 1927, 501–522).

This paper contains the following items.

1. New plants and a new section:—
   *Pittosporum Tobira* AITON var. *macrophyllum* NAKAI
   *Rubus* sect. *Dactylobatus* NAKAI for *Rubus palmatus, R. yenoshimanus, R. dulcis* etc.
   *Rubus kisoensis* NAKAI
   *Rhododendron niko-montanum* NAKAI var. *macranthum* NAKAI
   *Abelia curviflora* NAKAI
   *Abelia spathulata* SIEB. & ZUCC. var. *micranthum* NAKAI
   *Quercus acuta* THUNBERG var. *acutaeformis* NAKAI
   *Skimmia repens* NAKAI
   *Skimmia lutchuensis* NAKAI
   *Euonymus japonicus* THUNBERG var. *radicifer* NAKAI
   *Fraxinus longicuspis* SIEB. & ZUCC. var. *latifolia* NAKAI
   *Viburnum dilatatum* THUNBERG var. *microphyllum* NAKAI
   *Eupatorium hakonense* NAKAI, and its var. *intermedium*
   *Neolitzea Sieboldii* var. *prematura* NAKAI

2. New combinations and new names:
   *Skimmia japonica* var *fragrans* NAKAI for *Skimmia fragrans* CARRIÈRE
   *Skimmia japonica* var *falciformis* NAKAI for *Skimmia intermedia* CARRIÈRE
   *Arabis japonica* A. GRAY var. *stenocarpa* NAKAI for *Arabis stelleri* DC. var. *stenocarpa* FRAN. & SAV.
   *Boehmeria frutescens* THUNB. var. *concolor* NAKAI for *Boehmeria nivea* var. *concolor* MAKINO

*Villebrunnea fruticosa* (GAUD.) NAKAI for *Villebrunnea frutescens* BLUME

*Vanieria cochinchinensis* LOUR. var. *gerontogea* NAKAI for *Maclura geronto-gea* SIEB. & ZUCC.

*Fatoua villosa* NAKAI for *Urtica villosa* THUNBERG

*Actinodaphne longifolia* (BLUME). NAKAI for *Actinodaphne acuminata* MEISSNER

*Hedyotis pedunculata* NAKAI for *Laurus pedunculata* THUNBERG

*Neolitzea Sieboldii* (KUNTZE) NAKAI for *Litsea glauca* SIEB.

*Actinidia latifolia* (GARDN. & CHAMP.) NAKAI for *Actinidia Championi* BENTH.

*Indigofera incarnata* (WILLD.) NAKAI for *Indigofera decora* LINDL.

3.  Plants new to the Japanese Flora :
    *Laportea grossedentata* WRIGHT
    *Ledum palustre* L. var. *procumbens* NAKAI.

4.  Alteration of improper names :
    *Arabis glauca* BOISSIEU as the earliest valid name of *Arabis Boissieuana* NAKAI
    *Eupatorium japonicum* THUNB. as the earlier valid name of *E. stoecha-dosmum* HANCE
    *Eupatorium Fortunei* TURCZ. for *E. japonicum* THUNB. of FRANCHET, HEMSLEY and others
    *Boehmeria frutescens* THUNB. for *Boehmeria nivea* of SIEBOLD, BLUME etc.
    *Cinnamomum japonicum* SIEB. for *Cinnamomum pedunculatum* NEES, as NEES mistook *Laurus pedunculata* THUNB. for this plant.　　　Author.

**41. Flora Sylvatica Koreana XVI.** Takenoshin NAKAI. Publ. by Forestal Experiment station, Government General of Chosen, Keijyo. Sept. 1927; 92 pp. & 29 pls.

This is the critical revision and illustration of all species and varieties of Korean woody *Araliaceae* and *Cornaceae*. All cited books and papers are arranged alphabetically according to the author's names. Then the histories of investigations and explanations of economical plants follow.

In *Araliaceae*, the following species and varieties are treated of with aid of sixteen plates :

*Acanthopanax koreana* NAKAI; *A. sessiliflorum* SEEMANN; *A. chiisanense* NAKAI; *A. seoulense* NAKAI, sp. nov.; *A. rufinerve* NAKAI, sp. nov.; *Eleutherococcus senticosus* MAXIMOWICZ; *E. koreanus* NAKAI, sp. nov.; *Kalopanax pictum* (THUNBERG) NAKAI, comb. nov. et ejus var. *typicum* NAKAI & var. *magnificum* NAKAI; *Oplopanax elatum* NAKAI, comb. nov.; *Textoria morbifera* NAKAI, comb. nov.; *Aralia elata* SEEMANN.

Besides, the author made the following new combinations for the Chinese and Japanese plants :

*Eleutherococcus brachypus* NAKAI; *E. cissifolius* var. *normalis* NAKAI; *E. cissifolius* var. *scandens* NAKAI; *E. Giraldii* var. *inermis* NAKAI; *E. hypoleucus* NAKAI; *E. leucorhizus* var. *fulvescens* NAKAI; *E. leucorhizus* var. *scaberulus* NAKAI; *E. setchuensis* NAKAI; *Oplopanax japonicum* NAKAI.

He also made a new section *Herbaralia* of the genus *Aralia* including *Aralia racemosa* L., *A. cordata* THUNB.; and *A. glabra* MATSUM.

In *Cornaceae*, he described the following, using thirteen plates :

*Aucuba japonica* THUNB ; *Chamaepericlymenum canadense* ASCHERSON & GRAEBNER; *Cynoxylon japonica* var. *typica*, f. *minor*, var. *exsucca*, var. *viridis*; *Macrocarpium officinale* NAKAI; *Cornus alba* L.; *C. controversa* HEMSLEY; *C. coreana* WANGERIN; *C. brachypoda* C.A. MEYER.

In appendix, the discussion on the distributions of above species in East Asia is given, together with four maps of distribution.                       Author.

### 42. Notes on Japanese Ferns VI. Takenoshin NAKAI (Bot. Mag. Tôkyô **41**, 1927, 673–696).

This is a critical revision of *Osmundaceae*, *Schizaeaceae*, and *Gleicheniaceae* found in Japanese Empire.   The references and synonyms of the names of families, genera, sections, species and varieties are given.   The author distinguishes *Mertensia* WILLD. from *Gleichenia* SWARTZ; and as there is earlier *Mertensia* of ROTH he uses *Dicranopteris* BERNHARDI for the generic name.   Hence, the new combinations of sectional names are given as : *Dicranopteris* sect. *Diplopterygium* NAKAI, *Dicranopteris* sect. *Heteropterygium* NAKAI.   The following plants are enumerated : *Osmunda bromeliaefolia* COPELAND; *O. cinnamomea* L.; *O. Claytoniana* L.; *O. lancea* THUNB., *O. japonica* THUNB. et ejus var. *divisa* & var. *sublancea*; *O nipponica* MAKINO; *Lygodium scandens* SWARTZ var. *microphyllum* BONAPARTE; *L. flexuosum* SWARTZ; *L. microstachyum* DESVAUX et ejus var. *glabrescens* NAKAI, var. nov.; *L. japonicum* SWARTZ; *Schizaea digitata* SWARTZ; *Dicranopteris volubilis* NAKAI, comb. nov.; *D. laevissima* NAKAI, comb. nov.; *D. longissima* NAKAI, comb. nov.; *D. glauca* NAKAI et ejus var. *concolor* NAKAI, var. nov. ; *D. dichotoma* BERNHARDI.        Author.

### 43. Die Beziehung der Wasserpflanzen zum Eisen. (Japanisch m. deutsch. Zfg.).   Yôzô NAKAJIMA.   (Jour. Sc. Agric. Soc. No. **296**, 1927, 316–324).

Die Tatsache, dass der Reis sehr eisenbedürftig ist, wurde neuerdings von GILE und CARRERO vermittelst der Wasserkultur nachgewiesen und auch von RICHTER stark betont.   Der Verf. konnte auch das gleiche bei den Wasserpflanzen, wie *Zizania latifolia* und *Nuphar japonicum* beobachten, denn wenn man ihre Samen im eisenreichen Schlammboden, wo in der Natur diese Pflanzen gewachsen sind, keimen lässt, wachsen die daraus hervorgegangenen Keimlinge viel üppiger als diejenigen, deren Samen im gewässerten gemeinen Kulturboden gekeimt sind.   Viele andere Wasserpflanzen wie *Trapa natans*, *Sagittaria sagittifolia*, *Alisma Plantago*, *Sparganium longifolium*, *Myriophyllum spicatum* usw. sind dadurch ausgezeichnet, dass sie in ihrer Fruchtschale eine grosse Menge Eisen adsorbieren können.   So z.B. wenn man sie im eisenreichen Schlamm des Teiches, Sees oder Reisfeldes begraben, adsorbieren sie Eisen so stark, dass die Fruchtschale sehr geschwärzt werden, während wenn man den gleichen Versuch mit dem frischen Schlamm einer Gartenerde macht, so beobachtet man gar keine solche Erscheinung.   In dieser Beziehung sind die folgenden Experimente von Interesse.   Wenn man die Früchte der oben genannten Pflanzen für einiger Zeit unter der Lösung des Eisenchlorürs oder Eisenvitriols eintaucht und dann sie keimen lässt, zeigen die daraus hervorgegangenen Keimlinge viel üppigeres Wachstum als die Kontrolle, deren Samen im gewöhnlichen Wasser zur

Keimung angekommen sind. Das gleiche, und zwar noch auffallendere Verhalten kann man bei einer durch den japanischen Namen "Akamai" (roter Reis) bekannten Sorte von Reis beobachten, welche in ihrem Integumente einen rotbräunlichen Farbstoff aufspeichert. Der Verf. konnte auch die Tatsache experimentell nachweisen, dass die Reiskeimlinge ebenso üppig wachsen können bei dem Begraben der Samen im Schlamm eines Reisfeldes oder eines Teiches wie auch beim Eintauchen in einer Lösung von Ferroverbindungen. Bezüglich der biologischen Bedeutung der Eisenadsorption in der Fruchtschale äussert der Verf. die Meinung, dass sie nicht nur für die Wachstumsbeschleunigung des Samens, sondern auch für seinen Schutz dienen soll.

### 44. Untersuchungen über die Keimfähigkeitsdauer der Samen. (Japanisch m. deutsch. Zfg.). Yôzô NAKAJIMA. (Bot. Mag. Tôkyô **41**, 1927, 604-632).

Die folgenden Pflanzensamen, welche mit etwas wasserhaltigem CaCl in einer Flasche aufbewahrt waren, waren nach 9 Jahren und 2 Monaten noch mehr oder weniger keimungsfähig, während diejenigen, welche in dichtverschlossener oder offener Flasche ohne weiteres aufbewahrt waren, höchstens 4 Jahre lang ihre Keimungsfähigkeit bewahrt haben, nämlich *Setaria italica, Brassica campestris, Panicum Crus Galli,* var. *submuticum, P. Crus Galli* var. *frumentaceum, Fagopyrum esculentum, Sisyrinchium Bremudianum, Althaea rosaea, Impatiens Balsamina, Triticum vulgare, Hordeum sativum* var. *vulgare, Mirabilis Jalapa, Pharbitis Nil, Glycine Soja, Eleusine coracana, Cuscuta japonica, Oryza sativa.*

Unter den untersuchten Samen sind einige (*Hordeum, Triticum, Panicum, Zea, Brassica, Betula*) gegen starke Trocknung widerstandsfähig, während bei den andern (wie *Oryza, Phaseolus, Vicia, Setaria, Cryptomeria, Chamaecyparis*), welche in dieser Beziehung weniger widerstandsfähig sind, wird die Keimfähigkeit leicht durch das Trocknungsmittel (wie wasserfreies CaCl, konz. $H_2SO_4$, gebrannter Kalk, Phosphorsäureanhydrid usw.) herabgesetzt. Da der gebrannte Kalk sehr stark hygroskopisch wirkt, wäre es nicht ratsam, diese Substanz für die Aufbewahrung weniger widerstandsfähiger Samen zu benutzen (vgl. Japan. Jour. Bot. **3**, 1927, (8), Nr. 30. -Redaktion). Das schädliche Uebertrocknen der Samen kann man entweder durch den Gebrauch einer geringen Menge des Trocknungsmittels oder durch anfängliche Zugabe einer bestimmten Menge Wassers zu demselben vermeiden. Wenn die Samen durch zu starke Wasserentziehung beschädigt ist, so kann man den Schaden zu einem gewissen Grade vermindern, wenn man sie zuerst in Luft und dann im Feuchtkammer legt, um die Feuchtigkeit allmählich absorbieren zu lassen, und erst dann sie im Keimbett bringt.

### 45. Studies on the Pigment and its Formation in the Fungi. (Japanese). Hisao NAKAMURA. (Physiolog. Stud. **4**, 1927, 446-454).

This paper contains chiefly the review of investigation made by various authors concerning the subject cited in the title. The author has observed that *Septoria callistephi* parasitic on *Callistephus chinensis*, when cultivated on a certain medium produces the mycelium which is beautifully salmon-orange-coloured, either in dark or light. Its chemical reaction agrees generally with that of carotin but differs in certain respects.

### 46. Studies on Sclerotium Rolfsii Sacc. Part 6. Two Examples of Mutations.
(Japanese with English résumé). Kakugoro NAKATA. (Bult. Sc. Fak. Terk., Kjusu Imp. Univ. **2**, 1927, 292-307, 1 pl. and 3 figs.).

That there are at least 35 different strains of *Sclerotium Rolfsii* was some time ago indicated by the author. In his culture of the strain, origin **44**, he got a new form $M_1$ which is distinguished externally by fine and slender mycelia as well as very irregular large sclerotia with rough surface. It shows one-sided aversion towards the original strain and mutual aversion towards the other strains. The loss of pathogenicity, the production of spores in culture-media and the formation of blister-like sclerotia in early stage of development characterize the strain $M_1$. Another new form $M_2$ was derived from the strain, origin **6**; it agrees in all respects with the original, except the occurrence of the mutual aversion between them. $M_1$ and $M_2$ were found to breed true in the following generations. It was often stated that the so-called mutation in fungi is really either the result of hybridization or segregation. Since however in *Sclerotium Rolfsii* no mycelial fusion can take place between different strains, owing to their mutual aversion, all nuclei in one individual should be genotypically identical, hence it is clear that the appearance of the new strains $M_1$ and $M_2$ in the present case is due to the real genotypic change, i.e. the mutation in its proper sense.

### 47. On the Vitality and Pathogenicity of Bacterium Solanacearum Smith, a Case of Tobacco Wilt. (Japanese with English résumé). Kakugoro NAKATA. (Jour. Sc. Agric. Soc. No. **296**, 1927, 283-304).

It was observed that *Bacterium Solanacearum* which is one of the causes of tobacco wilt (s. Japan. Jour. Bot. 3, 1927 (100), No. 294.-Ed.) loses its vitality very soon when cultured in synthetic media, such as COHN's, CZAPEK's etc. but maintains it very long in natural media, such as milk or potato. It is also remarkable that the organism is far less resistant against the environment, as dryness, sunlight, temperature, etc. when cultured on the synthetic media than when cultured on the natural ones. And even in the latter, especially milk, when it is sterilized for long time and at high temperature the organism is less resistant. As to the pathogenicity it is quite the same with the vitality, because the organism cultured in natural media are much less pathogenic than when cultured in synthetic ones. The author thinks that the vitality and the non-pathogenicity of the organism are due to a certain vitamin-like substance contained in natural media. Whether this substance is the same for vitality and non-pathogenicity or not, remains undecided.

### 48. Principles for Controlling Tobacco Wilt. (Japanese with English résumé). Kakugoro NAKATA. (Jour. Sc. Agric. Soc. No. **298**, 1927, 389-411).

*Bacterium Solanacearum*, the cause of tobacco wilt is known to attack about fifty species of plants belonging to nine families. The organism loses its vitality in diseased tissue of host plants within seven months, and on seeds within a few days, while it may be alive during 14 months when transferred to soil. In the latter, however, it was observed that it dies out when soil water reaches its detrimental water content (D). The latter is 2.5% for sandy soil (water-holding capacity=W =30.7) and 9.7% for clay soil (W=69.1); the detrimental coefficient D/W ranges from 0.8 to 1.4 according to the kinds of soil. Further, the limits of pH, within which

the organism may be alive, ranges from 6.0 to 8.1. Still further, there are some microorganisms, in the presence of which *B. Solanacearum* cannot live, viz. *Aspergillus Oryzae*, *Actinomyces rutgerscens*, *Act. californicus*, *Act. violaceus-ruber*, *Bac. mycoides*, *Bac. fluorescens*, *Bac. cereus*, *Bac. proteus*, *Azotobacter chroococcum*. The principles of control of the wilt organism are therefore, (1) soil should be dried till its water content attains its detrimental stage of the organism, (2) the pH-value of soil should be adjusted to be outside 6.0 and 8.1, and (3) the soil should be infected with soil organisms inhibiting its vitality.

**49. Comparative Studies on Helminthosporium Diseases of Rice in the Pacific Regions.** Yosikazu NISIKADO. (Ber. Ôhara Inst. landw. Forsch. **3**, 4, 1927, 425-440 with 5 pls.).

The essentials of this paper were already reported in a paper in Japanese, which was abstracted in the preceding number of this Journal **3**, No. 4, (104).

Author.

**50. List of the Publications on Plant Pathology in Japan. I. Publications in 1926.** (Japanese). Yosikazu NISIKADO and Hiroyoshi MATSUMOTO. (Agr. Studies **11**, 1927, 132-168).

The writers are attempting to compile a complete list of the publications regarding plant pathology in Japan. As the first step of the attempt they have compiled a list of the publications issued during from January 1 to December 31, 1926 (the 1st. year of Syôwa). 403 entries are arranged alphabetically according to the author names under the following 7 subject headings:

| | | |
|---|---|---|
| (1) Mycology and Plant Pathology General . . . . . . | (Entries | 1- 47) |
| (2) Fungicides, Disinfectants and the other Means for Disease Control . . . . . . . . . . . . . . | ( ,, | 48- 97) |
| (3) Diseases of Common Crops . . . . . . . . . . | ( ,, | 98-222) |
| (4) Diseases of Technical Plants . . . . . . . . . . . | ( ,, | 223-258) |
| (5) Diseases of Fruit Trees . . . . . . . . . . . . . | ( ,, | 259-316) |
| (6) Diseases of Vegetables and Flower Plants . . . . | ( ,, | 317-394) |
| (7) Diseases of Forest and Ornamental Trees, including Bamboos . . . . . . . . . . . . . . . . . . . | ( ,, | 395-403) |

A list of publications in 1927, as well as that of those in 1921—1925 will be published in near future.

Authors.

**51. Studies on the Uspulun Treatment of Cereal Seeds against the Helminthosporioses** (Japanese). Yosikazu NISIKADO and Chûichi MIYAKE. (Agr. Studies **11**, 1927, 36-64.)

The writers studied the germicidal effect of uspulun solution of various dilutions for various durations of exposure against the conidia of *Helminthosporium Oryzae* BREDA DE HAAN and *Helm. gramineum* RAB., respectively. Effects of uspulun treatment upon germination of seeds of rice and barley were also studied under various combinations of dilution of uspulun, duration of exposure, and temperature of solution. Field experiments were also carried out for three years, after the treatment of barley seed against the stripe disease caused by *Helm. gramineum* RAB.

According to the writers' results, the helminthoporiose of the rice plant in seed beds may safely be controlled by the seed treatment with comparatively dilute solutions of uspulun (1/800—1/1200) for 48 hours at about 20°C. The leaf stripe disease of barley was checked almost completely by the seed treatment with 1/800 solution of uspulun for 12-24 hours at about 10°C.                                    Authors.

**52. On the Control of Flowering Time of Paddy Rice-plants by the Action of Light.** (Japanese with English résumé). Yakiti NOGUTI. (Jour. Sc. Agric. Soc. No. **299**, 487-500, 2 figs.).

In the rice breeding it is often unable to make the cross between two strains when they differ markedly in their flowering time.

The author has made the following experiments on the variety " Aikoku." The plant was exposed in July, (1) to daylight during 5-8 hours per day, (2) to normal daylight condition, and (3) to daylight and electric light at night. The first group of plants began to flower one month earlier (end July) than the second (end August), while the third did show no sign of flowering even as late as October 15. Thus the rice-plant was shown to be a short-day plant in GARNER and ALLARD's sense, and we may take profit of this property in order to perform the hybridization of two strains which so considerably differ in their flowering times, that one month intervenes between them.

**53. Ueber den Einfluss der Aussenbedingungen auf das Blütenöffnen der Reispflanze. V. Trockenheit.** (Japanisch). Yakiti NOGUTI. (Jour. Sc. Agric. Soc. No. **301**, 1927, 568-573).

In der Natur kann das Blütenöffnen der Reispflanzen sogar unter 40% Feuchtigkeit stattfinden, doch schon unter 70% nimmt die Zahl der öffnenden Blüten bedeutend ab und unter 55% geschieht dieser Vorgang sehr selten. Die Experimente, wobei die Rispen mit zu öffnenden Blüten im Glasrohr mit Chlorkalk gelegt sind, haben die gleichartige Resultate ergeben. Es wurde weiter gefunden, dass die plötzliche Abnahme der Feuchtigkeit das Blütenöffnen beschleunigt und auch dass das Optimum-Temperatur für diesen Vorgang=30°C beträgt, wenn die Luftfeuchtigkeit unter 70% ist. Die starke Trockenheit verhindert weder das Antherenöffnen noch die Bestäubung, doch wird dadurch das Fruchtungsprozent bedeutend herabgesetzt, was hauptsächlich der Beschädigung bzw dem Tod der Narben zu verdanken ist.

**54. Ueber die Befruchtungsfähigkeit der Narbe und Pollen bei Wasserreispflanzen.** (Japanisch m. deutsch. Zfg.) Yakiti NOGUTI und Nariyosi HAMADA. (Jour. Sc. Agric. Soc. No. **300**, 1927, 515-524 mit Abbild.).

Am 1., 2., 3., 5. bzw 7 Tage nach der Kastration wurden die Blüten mit den neulich gesammelten Pollenkörnern bestäubt. Es wurde dabei gefunden, dass die Befruchtung noch am 5. Tage erfolgen kann, aber später nicht mehr, und dass die Prozentzahl der Fruchtbildung am 2. Tage das Maximum erreicht und am 3. Tage schon abzunehmen beginnt. Die Blüten, wobei die Bestäubung vorgenommen wurde bevor noch die Blüten innerhalb der Blattscheide verborgen bleiben, zeigten ein ziemlich hohes Fruchtungsprozent.

Entries  52-54

Die Pollenkörner wurden bei normaler Zimmerfeuchtigkeit, 40% Feuchtigkeit und absoluter Trockenheit aufbewahrt, und zwar während 5 Stunden oder 1-5 Tagen und dann für die Bestäubung benutzt. Es wurde dabei festgestellt, dass sowohl die absolute Trockenheit als auch die 40% Feuchtigkeit die Befruchtungsfähigkeit des Pollens bedeutend herabsetzen und dass auch sogar bei der Zimmerfeuchtigkeit das Pollen meistens nach kurzer Zeit abstirbt, wenn selten es 50 Stunde lang befruchtungsfähig bleiben kann.

**55. On the Structure and Affinities of Some Fossil Tree-ferns from Japan.** Yudzuru OGURA. (Jour. Fac. Sc., Imp. Univ. Tôkyô, Sec. III (Botany) **1**, 1927, 351-380, 7 pls. and 13 text-figs.).

Three new genera of fossil tree-ferns from Korea and Japan proper are established, viz. *Cyathocaulis* incl. *C. naktongensis*, *Cibotiocaulis* incl. *C. Tatiwae*, and *Cyathorhachis* (petiole) incl. *C. Fujiiana*. About each of them the external features, the inner and the histological structure are described in detail. The stem structure of *Cyathocaulis* and *Cibotiocaulis* agrees with that of the recent Cyatheaceae, especially in having the meristeles curved in wavy form, each of which is surrounded by sclerenchymatous sheaths, and in having the medullary bundles. The two fossils just mentioned are however chiefly distinguished as to their internal structure from the recent Cyatheaceae by the meristic margins projecting, not only outwards into the cortex, as it is the case in the latter, but also inwards into the pith, and also by having the root-traces, not only in the cortex, as in the latter, but also in the pith. *Cyathocaulis* and *Ciboticaulis* are distinguished from each other by the fact that in the former petioles fall off clean from their very bases, while in the latter petiolar bases remain on the stem surface.

*Cyathorhachis* is a Mesozoic tree-fern petiole or rachis. Its vascular bundles are separate and similar in arrangement to those of the recent Cyatheae and consequently this genus is considered to represent the leaf-axis of this tribe.

**56. Mikrochemische Untersuchungen des mit Kupfervitriol imprägnierten Holzes von Cryptomeria japonica Don.** K. OHARA. (Japan. Jour. Bot. **3**, 1927, 323-334, 1 Taf.).

**57. On the Systematic Importance of the Spodiograms of the Leaves of the Bambusaceae.** (Japanese). Kiichi OHKI. (Bot. Mag. Tôkyô **41**, 1927, 719-731, figs.)

The " Aschenbild " of leaf epidermis of various Japanese *Sasa* species was made. Since their leaves contain much silica, it indicates very clearly the form and arrangement of epidermal cells, the form of stomata, etc., etc. The author was able to distinguish various *Sasa* species, as *S. bitchuense, hidaensis, Okudana,* etc. by the " Aschenbild " of their respective leaves, and gives an analytical key of these species founded on this character.

**58. Sur une nouvelle Méthode de l'Ampélométrie.** (Japonais avec le sommaire français). Yasusi Oinoue et Sintaro TANABE. (Jour. Sc. Agric. Soc. No. **300**, 1927, 525-534, 10 figs.).

L'incertitude de l'ampélométrie de Louis RAVAZ doit être due à la petitesse des unités qu'il a choisies. De plus les angles α, β, et γ etc. employés par lui sont influencés par la variabilité individuelle beaucoup plus que les angles que font les lignes droites qui joignent les deux extrémités des nervures. On peut constater que la direction de la base des nervures a moins d'importance pour la détermination de la forme générale des feuilles que celle des dites lignes droites et les angles qu'elles tiennent entre eux.

Nous avons donc préféré la méthode suivante :

D'abord nous avons traité des sommets des lobes par la coordonnée rectangulaire.

Nous avons ensuite pris la ligne droite entre deux sommets de la nervure médiane comme l'axe des abscisses et le point d'insertion du limbe comme l'origine de cette coordonnée.

Ayant donnée le nombre 10 à la longeur de la nervure médiane, nous avons calculé les valeurs approchées jusqu'au premier ordre décimale.

Enfin, nous avons pu trouver deux lois suivantes pendant les travaux :

1. Sur les feuilles (même asymétriques) la ligne droite entre deux sommets des lobes latérales supérieures font l'angle droite avec les ligne droites entre deux sommets de la nervure médiane.

2. La moitié supérieure de toutes les lobes ont la forme similaire.  Auteurs.

**59. Icones of Japanese Algae.** Kintarô OKAMURA. Vol. **5**, No. 7–9, 1926–1927, 15 pls. and 61 pp. text (in Japanese and English).

The following species and varieties are contained in these numbers :

No. 7 : *Undaria pinnatifida* SUR., *U. undarioides* (YENDO) OKAM., *U. Peterseniana* (KJELLM.) OKAM., *Eucheuma papulosa* COTTON et YENDO, *Crouania attenuata* (BONNEM.) J. AG.

No. 8 : *Ecklonia cava* KJELLM., *E. kuromé* OKAM. n. sp., *Eisenia bicyclis* (KJELLM.) SETCH., *Eckloniopsis radicosa* (KJELLM.) OKAM. n. gen.

No. 9 : *Gracilaria gigas* HARV., *Trematocarpus pygmaeus* YENDO, *Chondria expansa* OKAM. n.sp., *Gloiopeltis furcata* P. et R., *Baylesia plumosa* SETCH.

**60. Analytical Key of the Generic Names of the Japanese Algae.**  Third ed. (Japanese).  Kintarô OKAMURA.  Tôkyô 1927, 47 pp.

162 genera of the Japanese red, brown, and green algae are contained in the analytical key.  The explanation of technical terms is appended.

**61. Report of the Biological Survey of Mutsu Bay.  4.  Marine Algae of Mutsu Bay and Adjacent Waters 1.**  Kintarô OKAMURA. (Sc. Rpt. Tôhoku Imp. Univ.  IV. Ser. (Biology) **3**, 1927, 1–17).

An enumeration of the Chloro- , Phaeo- and Rhodophyceae found in Mutsu Bay, Northern Japan by several collectors and determined by the author.  The number of species is 85 in all.

**62. On the Nature of the Marine Algae of Japan and the Origin of the Japan Sea.** Kintarô OKAMURA. (Bot. Mag. Tôkyô **41**, 1927, 588–592).

The Japanese algae which may be said to have been hitherto definitely determined are 660 species and 6 varieties in all. Of these 298 species and 5 varieties are indigenous to Japan, i.e. half of the whole algal flora. The region which contains so many indigenous species may well be considered as that which is quite distinct from others, hence a special name, "Japan Flora" given by the author to the marine flora of Japan.

When the algae found in the Pacific and Japan Sea are examined separately, 206 are common to both, while 445 are proper to the Pacific Sea, and only 15 to Japan Sea. This remarkable difference of algal flora between the Pacific and Japan Sea, and also the presence of very few indigenous species in the latter is explained by the author as follows: the Pacific Sea must have been formed early at the beginning of the earth's history, while Japan Sea was formed much later by depression or any other geological accident, and came to communicate with the Pacific Sea. Hence the richness of indigenous forms in the latter and their scarcity in the former.

**63. Reducing Division in Triploid Primula.** (Japanese with English résumé). Tomowo ONO. (Bot. Mag. Tôkyô **41**, 1927, 601–604, 8 figs.)

The author investigated the reducing division of the pollen mother-cells in triploid *Primula* "Sasanonami," one of the garden varieties of *Primula Sieboldii* (2n=24). At diakinesis there appear usually 12 trivalent chromosomes. The distribution of chromosomes in the first division anaphase is irregular, and the most usual numbers of chromosomes in the second division metaphase are 16–20. The formation of pollen-tetrads proceeds normally and no abberant microspores are found.

Author.

**64. Chromosomenzahl von Rumex sanguineus.** (Japanisch). Tomowo ONO. (Bot. Mag. Tôkyô **41**, 1927, 632–633, 2 Abbild.).

Nach der Verfs. Beobachtung ist die Haploidzahl der Chromosomen bei *Rumex sanguineus* 10. Die gleiche haploide Zahl wurde schon früher bei *R. maritimus*, *crispus* und *flexuosus* gefunden.

**65. On the Relation of Temperature to the Longitudinal Growth of Leaves of Rice-plant.** (Japanese). Takashi SASAKI. (Proc. Crop Sc. Soc. Japan No. **1**, 1927, 23–42, 10 figs.).

The uppermost leaves were taken for the experiment. Their longitudinal growth goes much better at 31° than at 35°. It is somewhat prevented at 37°–39,5°, though when plants will be replaced at 30° the original growth power will be restored to a certain extent. At 41°–43° the growth is minimum, and at 45° it nearly stops.

The growth goes much better at 30° than at 25°, and at 21° than at 17°. At 7°–8° it nearly stops, though if plants are replaced at higher temperature it begins to take place again.

The curve representing the growth variation differs in its form from that representing the variation of air temperature and resembles rather that concerning the variation of soil temperature.

### 66. A Method of Accelerating the Formation and the Germination of Hibernating Spores in Fungi. (Japanese). Kanekichi SAWADA. (Jour. Nat. Hist. Soc. Formosa **17,** 1927, 197–200).

In nature the hibernating sexual spores of the Phycomycetes are rarely met with. This is due perhaps to the influence of the other organisms living together with them which prevent the healthy development of spores. Also even in the culture practised in the laboratory, where of course no such organisms are present near them, the sexual spores are rarely produced, and this is due either to self-poisoning or to the influence of organic acids and other waste substances produced by the putrefaction of hosts.

The author which has taken the above facts into consideration has devised a method for accelerating the formation of sexual spores. To cite one instance. He has inoculated the oranges with the pure culture of *Phytophthora citricola,* and put their pieces in the ALLIHN's tube which is in use in the chemical laboratory for the filtration purpose. He has poured every day sterilized distilled water into the tube and filtered away the substance exuded out of orange pieces therein, in this way he could get after a few days many sexual spores. The author used the same method with success for accelerating the germination of oospores, as for instance those of *Phytophthora Cactorum* on *Boehmeria nivea* and *P. citricola* on oranges.

For the experiments on the formation of sexual spore on the larger host bodies or the germination of large sclerotia he has devised a special apparatus based on the same principle as above, with which he could for example accelerate the oospore-formation of *Empusa* sp. parasitic on the worms, the germination of *Sclerotinia Fuckeliana* parasitic on lettuce, etc. etc.

### 67. Report of Studies on Formosan Fungi. III. (Japanese). Kanekichi SAWADA. (Rpt. Agric. Dep., Research Inst. Formosa No. **27,** 1927, 62 pp., 7 pp. index, 4 pls. and figs.).

The following fungi in Formosa are enumerated and described in detail, of which many are new species: *Pythium hydnosporum* (MONT.) SCHROET., *P. spinosum* SAWADA, *Albugo Ipomoeae-Hardwickii* SAWADA sp. nov., *Phytophthora Boehmeriae* SAWADA sp. nov., *P. Cactorum* (LEB. et COHN) SCHROET., *P. citricola* SAWADA sp. nov., *P. Cyperi-rotundati* SAWADA sp. nov., *P. Melongeneae* SAWADA, *P. Tabaci* SAWADA sp. nov., *Basidiophora entospora* ROZE et CORNU, *Plasmopara Halstedii* (FARLOW) BERL. et DE TONI, *Sclerospora Oryzae* BRIZI, *Bremia sonchicola* (SCHLECHT.) SAWADA, *Peronospora Aparines* (DE BARY) GÄUM., *P. aquatica* GÄUM., *P. Bothriospermi* SAWADA sp. nov., *P. Euphorbiae-thymifolia* SAWADA sp. nov., *P. Stellariae-aquaticae* SAWADA, *P. Stellariae-uliginosae* SAWADA, *P. Laurii* BRAUN.

It must be added that all his studies were made on living specimens, and the measurement of spores has been performed on as many individuals as possible.

**68. Ueber den Einfluss des Ausschneidens der Blätter und Wurzeln auf das Wachstum der Bananen.** (Japanisch). Kanekichi SAWADA. (Notizen aus landw. Abteil. der Untersuchungsanstat Formosa **51**, 1927, 57 S.)

Die Schrumpfkrankheit der Bananen ist zweifellos keine parasitäre, doch ist die Ursache davon noch ganz unbekannt. Um zu untersuchen, ob die Beschädigung der Blätter oder Wurzeln diese Krankheit verursachen kann, hat der Verf. dabei eine Reihe von Experimenten ausgeführt.

Alle Blätter wurden weggeschnitton, ausgenommen ein einziges Herzblatt und wenn später ein neues Herzblatt erschienen ist hat man das letztere allein verbleiben lassen und das andere Blatt weggeschnitten. Dieser Prozess wurde mehrmals wiederholt. Dank solcher Versuchsweisen nahmen die neu produzierten Blätter immer an Grösse ab und schliesslich ist die ganze Pflanze zugrunde gegangen. Die mikros-kopische Untersuchung der Wurzel solcher Pflanzen zeigte, dass sie ganz stärkeleer ist. Deshalb kann man schliessen, dass der Tod der Pflanze dem durch die Kleinheit der Assimilationsfläche bedingten Nahrungsmangel zu verdanken ist, sodass wenn man bei den obigen Versuchen immer zwei Herzblätter statt einen verbleiben gelassen hat, konnte die Pflanze noch viel länger am Leben bleiben.

Bei einer anderen Reihe von Experimenten hat der Verf. im Boden um der Wurzel einen 1/3 m. tiefen und ungefähr 1/6 m. weiten Graben gemacht und alle dort befindlichen Wurzeln ausgeschitten; diese Arbeit wurde je einmal pro Monate wiederholt. Bei diesem Versuche ist die Zeitdauer für die Blattbildung bedeutend verlängert, doch bemerkte man keine Blattgrössenabnahme und schliesslich ist die Pflanze zur Blütenproduktion angekommen.

Hinzuzufügen ist, dass in allen solchen Versuchen niemals die Schrumpfkrankheit verursacht worden ist.

**69. The Effect of Electric Discharges on the Rates of Growth of Plants.** (Japanese.) Motoji SHIBUSAWA and Keita SHIBATA. (Journal of the Institute of Electrical Engineers of Japan, No. **473**, 1927, 1-42, 14 figs.)

In the present paper the authors describe the results of experiments on the effect of electric discharges upon the rate of growth of certain plants. The currents applied are of three kinds, viz. high-tension A.C., high-tension D.C. and high-tension-high-frequency current. The experiments were carried out, since 1921, in the Botanical Garden of the Tokyo Imperial University.

Field experiments on the electo-culture have hitherto given no consistent results, some workers reporting a considerable increase in crop production, while others stating no such effect. The authors conducted their experiments in a green house so as to keep culture conditions uniform for both the electrified and control plants. The electric current of very low intensity was induced in the plants by applying high voltage to a thin wire net-work suspended at a distance of 15–30 cm above the plant. The determination of the result was done by estimating the dry weight of plants, grown as fully as possible under the conditions of experiments.

*Preliminary tests with high-tension A.C.* Several kinds of plants were treated with high-tension A.C. of 50 cycles and at 21,000 volts. The electrified plants have shown mostly an accelerated growth.

*High-frequency current experiments.* High frequency voltage was produced by a set of three quenched spark-gaps in series. The fundamental frequency of the wave was about 130,000 cycles and the E.M.F. measured with needle point spark-gaps was about 13,000 volts (crest value—spark distance being 1.5-1.6 cm.) The results obtained were not uniform but in a recent experiment the electrified buckwheat gave the yield 12.6% greater than the control.

*High-tension D.C. experiments.* High-tension D.C. was obtained by rectifying 50-cycle A.C. by means of a kenotron. The aerial net-work was kept as (−) pole while the plants (+) pole and the voltage was held unchanged in some cases, but in others controlled within 10,000 and 15,000 volts (effective, measured at A.C. side), so as to keep the current passing through the plant nearly same. The first few experiments did not show much differences in the growth between the electrified and control plants. But the effect upon tobacco plants was rather conspicuous, the increase in dry weight being 21.7% of the control.

*Experiments with the coleoptile of oats.* Besides the culture experiments above mentioned, the authors have made more minute observations on the change of the growth rates of the coleoptile of oats under the influence of electric discharges. The temperature of the dark chamber in a thermostat was kept constant within a range of 0.01°C. A charged point of platinum wire was fixed at a distance of 30 mm just above the plant. The rate of growth was measured every 5 minutes with a horizontal microscope which was illuminated by weak red light while taking the reading. From the experiments it was concluded :

1. The control test shows that the normal growth rate of coleoptile is quite uniform.

2. The three kinds of electric currents show the effect of almost the same nature, viz. "immediately after the discharge the growth rate diminishes, but after about 15 minutes it tends to increase and attains a maximum in about $\frac{1}{2}-\frac{3}{4}$ hour, often reverting to the original rate after 1—2 hours." The phenomena observed may be appropriately termed "the electro-growth reaction."

3. It would seem that a certain voltage at a certain distance between the poles gives the maximal growth effect.

4. The observed change in growth rates is due solely to the electricity applied. The other physical and chemical agencies possibly induced by the silent discharge were not found affecting the growth of coleoptile.

The authors have made further series of supplementary experiments, such as the stimulation of sprouting of winter buds, the sensitive movement of *Mimosa pudica*, the acceleration of transpiration rates, the electrotropic curvatures etc.

Authors.

**70. Ueber die Ursache der Entstehung der wurstförmigen Zellen in der Kahmhaut und die spaltungsartige Keimung bei den Saccharomycesarten.** (Japanisch). Kinsi SUMINOE. (Jour. Sc. Agric. Soc. No. **296**, 1927, 305-310, 4 Abbild.).

Es ist wohl bekannt, dass die Hefezellen der Kahmhaut wurstförmig sind, statt rundlich oder elliptisch zu sein, wie bei den anderen Zellen. Die Ursache davon ist noch nicht genau bekannt. Der Verf. hat bei einer Rasse japanischer Sakehefe

experimentell festgestellt, dass die Bildung von wurstförmigen Zellen dem Nah-
rungsmangel zu verdanken ist, und dass auch das Vorhandensein der Säuren in den
Kulturmedien zu ihrer Bildung beiträgt, denn sie verhindern die Nahrungsaufnahme.

Der Verf. hat auch die Tatsache konstatiert, dass zur Zeit des Nahrungsmangels
gewisse *Saccharomyces*arten statt der gewöhnlichen Sprossung eine mehr oder
minder spaltungsartige Keimung (wie bei *Saccharomycodes*) ausführen.

Die folgende Tatsache wird von Interesse sein. Wenn man die Kulturlösung,
worin die Gärung durch eine Hefeart schon einmal stattgefunden hat, sterilisiert und
sie wieder für die Kultur dieser Hefe benutzt, wird die Kahmhautbildung viel
schneller zustande kommen, als wenn man eine frische Lösung ins Gebrauch nimmt.

### 71. On a Property of Twining Plants II. (Japanese with English résumé).
Seitaro SUZUKI, Hukuyosi OMORI and Yositeru ARAKI. (Bul. Sc. Fak. Terk. Kjuŝu
Imp. Univ. **2**, 1927, 389-398, 3 text-figs.).

The following relation between $h$, pitch of a twining plant and $r$, radius of its
cylindrical support will explain the authors' experiment which is more extensive than
that announced in the former report (s. Japan. Jour. Bot. **3**, 1927, (111), No. 329),
namely,

$$h = a \log r + b$$

where $a$ and $b$ are constants.

The characteristic radius (=critical radius of the former report) which has a
meaning as far as the support is thin, was calculated on certain twining plants by
means of the formula $h = 2\pi \sqrt{r(\rho - r)}$. Its value was found to vary between 1.49-11.79
cm.

### 72. A Bacterial Disease on Mulberry and its Causal Organism. (Japanese
with English résumé). Seito TAKIMOTO. (Bult. Sc. Fak. Terk., Kjuŝu Univ. **2**,
1927, 317-323).

A mulberry disease which is much prevailing in certain regions of Southern
Japan is characterized by the appearance on leaves of water-soaked-like spots of
polygonal or irregular outline which later become brown; leaves are sometimes
deformed, and black streaks and canker on shoots and branches are the final
symptoms. The disease was revealed to be due to the action of white bacteria always
associated with yellow ones which are quite harmless. White bacteria are recognized
to be *Bacterium Mori*.

### 73. On the Development of the Embryo-sac and Fertilization of Acalypha
**australis, L.** (Japanese with English résumé). Shinkichi TATEISHI. (Bot. Mag.
Tôkyô **41**, 1927, 477-485, 2 pls.).

In *Acalypha australis* the four macrospore-nuclei produced by the hetero- and
homoetypic divisions of the nucleus of the embryo-sac mother-cell take part in the
formation of one embryo-sac. Between these four nuclei no trace of cell-walls, even
ephemeral, do appear at all, and each of them undergoes two successive divisions, so
as to form a tetrad composed of four nuclei. One nucleus of each tetrad moves
towards the center of the embryo sac, and forms there a group of four polar nuclei.
The three remaining cells of each tetrad form three triads, of which the one situated

near the micropyle is the egg apparatus. The author thinks with MODILEWSKI that the embryo-sac of *Acalypha* is tetrasporic and corresponds to the combined form of four monosporic tetranucleate embryo-sacs, which are found in some other Euphorbiaceae. After the fertilization these triads other than the micropylar go to disorganization. The mature endosperm contains about 250 cells.

### 74. Experimentelle Studien über die Keimung der Samen von Trapa natans L. Yasufusa TERASAWA. (Bot. Mag. Tôkyô **41**, 1927, 581-596, m. Abbild.).

Die Samen von *Trapa natans* wurden im vermittelst alkalischer Pyrogallollösung O-frei gemachten Raume gelegt: ihre Keimung fand wie normal statt, doch dabei ist weder die Chlorophyll- noch Wurzelbildung zu bemerken. Der Autor hat auch das Verhalten ihrer Keimung in reinem O, und in der gewöhnlichen um $\frac{1}{2}$ bzw. $\frac{1}{3}$ durch reinen O ersetzten Luft studiert: er konnte die Tatsache konstatieren, dass ihre Keimung darin stattfinden kann, und zwar das Keimungsprozent der Menge der O-Zufuhr umgekehrt proportional ist. Die Keimung kann auch in reinem N oder H erfolgen, aber in reiner $CO_2$ nicht.

### 75. Neue grüne Algen als Nahrung fur die Schalenlarven der Auster. Saburô UEDA. (Jour. Imp. Fisher. Inst. **23**, 1927, 78-79, 2 Abbild.).

Eine neue Art von *Chlorella*, *C. pacifica* wird beschrieben und abgebildet. Vermehrung durch Zweiteilung oder Aplanosporen. Weder Schwärmsporen noch geschlechtliche Fortpflanzung.

### 76. Salvinia from the Honkeiko Group of the Honkeiko Coal-field, South Manchuria. Hisakatsu YABE and Seidô ENDÔ. (Japan. Jour. Geol. & Geogr. **5**, 1927, 113-115, 2 figs.).

In a complex of red shale, sandstone and conglomerate in alternation in Honkeiko (Pen-hsi-hu) coal-field, South Manchuria, remains of a species belonging to the genus *Salvinia* were found, which resemble *S. elliptica* NEWBERRY from Carbonado in Washington, U.S.A. The plant bed was formerly regarded as Upper Cretaceous in age, but cited as Eocene deposit by late Dr. KNOWLTON. The discovery of *Salvinia* in the Honkeiko Group is interesting, so far as it excludes the possibility of the formation being older than the Upper Cretaceous.

### 77. Experimentelle Zytologische Beiträge. Gihei YAMAHA. I. Mitteilung. Orientierungsversuche an den Wurzelspitzen einiger Pflanzen. (Jour. Fac. Sc. Imp. Univ. Tôkyô **2**, 1927, 1-214, 13 Taf.). II. Mitteilung. Ueber die Wirkung des destillierten Wassers auf die Wurzelspitzenzellen von Vicia Faba bei verschiedenen Temperaturen. (Jour. Fac. Sc. Imp. Univ. Tôkyô **2**, 1927, 215-296, 2 Taf.). III. Mitteilung. Ueber die Wirkung einiger Chemikalien auf die Pollenmutterzellen von Daphne odora, Thunb. (Bot. Mag. Tôkyô **41**, 1927, 181-211, 1 Taf.).

Die I. Mitteilung enthält die Resultate von umfangreichen Versuchen über die Veränderungen des Zellinhaltes durch die Einwirkung verschiedener chemischen Reagentien, mit besonderer Berücksichtigung auf die Artefakte bei den in der mikroskopischen Technik üblichen Fixierungsmethoden. Die Abhandlung besteht aus dem experimentellen und theoretischen Teil. Im ersteren sind die Resultate der Einwirkung von anorganischen Säuren, Alkalien, Schwermetallsalzen, Salzen von

Erdalkalien und Erdmetallen, anorganischen Alkalisalzen, organischen Säuren, Salzen organischer Säuren und anderen organischen Verbindungen eingehend beschrieben. Die Versuche wurden hauptsächlich an den Keimwurzeln von *Vicia Faba* und auch an denselben von *Allium Cepa*, *Glycine Soja* und *Vigna chinensis* ausgeführt. Im theoretischen Teil werden die Wirkung der Säuren, die Permeabilität, die kolloidale Veränderungen des Protoplasmas, verschiedene Strukturmodifikationen zusammen-fassend besprochen.

In II. Mitteilung sind die Resultate der Einwirkung des destillierten Wassers auf die Wurzelspitzenzellen von *Vicia Faba* enthalten. Die junge Wurzel dieser Pflanzen wurden der Einwirkung derselben bei hoher Temperatur von 30°-50° ausgesetzt. Die in solcher Weise behandelten Materialien wurden in Zeitintervallen von 5-60 Minuten fixiert und die Veränderung des Zellinhaltes beobachtet. Dabei erwiesen sich die karyoplasmatischen Strukturen empfindlicher als die zytoplasmatischen. Verschiedene Struktur- und Mitosenmodifikationen wurden nachgewiesen, z. B. Kernentstellung, diffuse Färbung der ganzen Zellstrukturen, Niederschlagsbildung im Zytoplasma, zackig konturierte und flockig oder zackig strukturierte Chromosomen, ungleich rekonstruierte Schwesterkernenanlagen usw. usw.

In III. Mitteilung werden die Resultate der Einwirkung von verschiedenen Chemikalien, z. B. Salpetersäure, NaCl, Essigsäure, Methylalkohol, Xylol usw. usw. auf die Pollenmutterzellen von *Daphne odora* enthalten. Die Pollenmutterzellen erweisen sich dabei destillierten Wasser und wässerigen Lösungen verschiedenen Chemikalien gegenüber bedeutend empfindlicher als die Wurzelzellen derselben Pflanze, besonders bezüglich der karyoplasmatischen Strukturelementen.

Alle oben angedeuteten drei Mitteilungen enthalten eine grosse Fülle von interessanten Einzelheiten, welche natürlich unmöglich sind hier hervorgehoben zu werden und dabei an das Original studiert werden müssen.

**78. Physiological Researches on the Fertility in Petunia violacea. III. The Relation between the Secretion of Stigmas and the Fertility.** (Japanese with English résumé). Sadao YASUDA and Tokuji ARAI. (Bot. Mag. Tôkyô **41**, 1927, 553-559).

The stigma, of which the secretion has been washed away with water, is smeared with that from the stigma of a different plant and then pollinated with the pollen taken from the same flower as that of the pistil : the fertilizing percentage, the size of either unfertilized ovaries or of capsules produced by fertilization, the number, size, weight as well as the germinating percentage of seeds, the length of the seedlings, etc. are found to be larger than those observed when the ordinary intra-self pollination is practised.

The germinating percentage of the pollen was tested with two kinds of artificial media, in each of which the amount of sugar (=1%) and the pH-value (=5.5) were optimum for their germination ; to the one the secretion from the stigma of the same flower and to the other that from the stigma of a different individual was added. The results have clearly shown that the secretion from a different individual was beneficial to the germination of pollen than that from the stigma of the same flower. (S. Japan. Jour. Bot. **3**, 1927, (119), No. 350).

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Entry  78

# Abstracts Nos. 79–154

(Referring to the principal papers on Botany and related subjects which
have appeared in Japan chiefly during January-June 1928)

**79. Studies on the Correlation between the Size of the Fruit and Some
Characters in the Japanese Pear.** Yoshichi ASAMI and Chang CHIH HU. (Jour. Sc.
Agric. Soc. No. **303**, 1928, 55–66, 3 pls.).

The correlation between the size of the fruit and the age of the spur system
bearing it was studied. It was found that there is no noticeable correlation between
them in the spur system which is younger than ten years. In the older spur system
which had been rejuvenated, producing vigorous shoots the fruits borne thereon are
as large as those borne on that younger than ten years. In the old spur system
which had produced no renewal shoots, however, the fruits are smaller in average.
Between the size of fruit on one side, and the number of seeds contained therein or
the weight of seeds on the other there is a moderate positive correlation. Between
the size on one side and the form of fruit or the relative size of its core on the other
no correlation was observed.

**80. Die Myxomyceten gesammelt 1924-1927 in dem Botanischen Garten
zu Tokyo.** Yoshikazu EMOTO. (Bot. Mag. Tôkyô **42**, 1928, 196–203, 2 Abbild.).

Die Aufzählung von 75 Arten, die zu 25 Gattungen gehören. Eine neue Art,
*Arcyria nigella* wird beschrieben und abgebildet.

**81. Genetic Studies of Leaf-characters in Morning Glories VII. On the
Spiral Torsion and the Abnormal Bract.** (Japanese with an English summary).
Tokio HAGIWARA. (Bot. Mag. Tôkyô **42**, 1928, 85-95).

A certain number of individuals, of which the leaf-stalk and stem are spirally
twisted have appeared unexpectedly in $F_2$ of a crossing, in spite of the fact that $F_1$ as
well as its both parents were quite normal. The ratio, normal : twisted was about
3:1. The culture has shown that the twisted character behaves as recessive to
normal. The first appearance of twisted plants may be due to a mutation. The
factor $t^w$ for it does not work, unless the factor **p** for " Kudyaku "-leaf is not pre-
sent in the same zygote. The crossover percentage between these two factors may
be 25.

There are some individuals characterized by the facts that firstly the flower is
borne at the apex of the flower-branch having some leaves and secondly the bract is
abnormally large. These characters are due to a factor **a** which is recessive to
normal. The crossover percentage between **a** and the factor **k** for " Tombo "-leaf is
33,33.

**82. Genetico-physiological Studies on the Formation of Pigments in
Several Organs of Japanese Morning Glories.** (Japanese and English). Tokio
HAGIWARA. (Bot. Mag. Tôkyô **42**, 1928, 137–154, 293–301).

According to the results of the former investigators the flower colour of the

Morning Glory is due to the two complementary factors, but the author's experiments have shown that it should be due to the three factors, viz, **C**$^a$ , **C** and **R**, so that the full-coloured flower has the factorial composition **C**$^a$ **CR**. All flowers lacking any of these factors, i. e. **C**$^a$ **Cr**, **C**$^a$ **cR**, **C**$^a$ **cr**, **c**$^a$ **CR**, **c**$^a$ **Cr**, **c**$^a$ **cR**, **c**$^a$ **cr**, have white corolla, though the tube, stem, and seed may be coloured in some of them. By the comparison of all these white-typed flowers the author could ascertain the fact that the factor **C** refers to the colour of the flower tube, and **R** to that of stem.

The results of the chemical treatment of these flowers, i.e. of their treatment by ammonia vapour (yellow reaction due to flavones) and of that of alcoholic extract by HCl+magnesium powder (reduction) have led the author to the following conclusion : the chromogenic substance giving rise to anthocyanin in corolla may be one of the colouring matter of the flavone group of which the side-benzene nucleus has OH or OCH$_3$ (SHIBATA).

The presence here of another flavone is probable. The colourless anthocyanin (pseudobase) was detected in stems and seeds. In the former both flavones and phlobaphenes may be present, but in the latter phlobaphenes only.

The ground colour of corolla is either white or yellow. Though in the normal coloured flower the distinction between the two is naturally not evident, it is quite clear in spotted flowers. The yellow ground colour is due to the substance, of which the factors **Y**, **C**$^a$ and **C** are responsible for the production and this substance may be another flavone.

In the flower of Morning Glory we may distinguish the following colour groups, viz. blue, purple, scarlet, grayish blue, grayish purple, and grayish red. The author discusses the connection between the factors lying at the base of these colour groups and various pigments, as peonin, pelargonin, etc., etc.

The author finally discusses on the basis of the genetical formulae for green, yellow and albino seedlings the possible relationship of the factors contained in them with several constituent pigments of chlorophyll.

**83. On a New Species of *Brainea* from Formosa.** (Japanese and Latin diagnosis). Bunzô HAYATA. (Bot. Mag. Tôkyô **42**, 1928, 236–237, figs.)

A species of *Brainea*, which was formerly considered to be *B. insignis* HOOKER should be a new species, for which the author gives the name *B. formosana* and its Latin diagnosis.

**84. On the Systematic Importance of the Stelar System in the Filicales, II.** (Japanese). Bunzô HAYATA. (Bot. Mag. Tôkyô **42**, 1928, 301–311, 5 figs.)

This is the continuation of his painstaking studies on the steles of various ferns (s. Japan. Jour. Bot. **4**, 1928, (4), No. 11). The following five ferns are treated of in the present paper : *Acrophorus stipellatus, Micropolypodium pseudotrichomanoides, Monachosorum subdigitatum, Protangiopteris Somai, Peranema formosana*. Of these ferns *Micropolypodium* and *Protangiopteris* are the new genera created by the author to include certain species which were formerly reckoned among *Polypodium* and *Archangiopteris* respectively.

**85. Experiments Relating to the Toxic Action by the Causal Fungus of Helminthosporiose of Rice.** Takewo HEMMI and Isamu MATSUURA. (Proc. Imp. Acad. **3**, 1928, 185–187).

The theory that the wilting of plants suffering from the fungus disease may be due to a simple mechanical plugging of the water-conducting vessels by the vegetative growth of the causal fungus is now giving place to another. According to the latter theory certain toxic substances excreted by the fungus may be responsible for the wilting. The authors' experiments consist in making the filtrate from the mycelial mass of the cultures of *Helminthosporium Oryzae* and inserting freshly cut ends of stems of horsebeans into this filtrate. Wilt symptoms of the plants had set in considerably earlier than in the controls. The change of pH-value of the medium was proved to be not at all responsible for the wilting.

**86. Experiments Relating to Stimulative Action by the Causal Fungus of the " Bakanae " Disease of Rice.** Takewo HEMMI and Fusataro SETO. (Proc. Imp. Acad. **3**, 1928, 181–184, 2 figs.).

The disease of rice called "Bakanaebyô" is characterized chiefly by the fact that the leaves and culms of attacked seedlings become abnormally taller and more slender than in usual cases. A fungus belonging to the genus *Fusarium* was isolated from diseased seedlings, and by inoculation experiments it was proven that it is the causal fungus of the present disease. The experiment which consists in giving the filtrate of cultures of a certain strain of *Fusarium* isolated from a scabbed seed has proven that the substance exsuded by this fungus is responsible for the overgrowth of aerial parts characteristic of the disease. The same experiments with another strain of *Fusarium* and *Helminthosporium Oryzae* have failed to produce any overgrowth of aerial parts.

**87. A Provisional List of the Melampsoraceae of Saghalien.** Naohide HIRATSUKA. (Bot. Mag. Tôkyô **42**, 1928, 26–32).

An enumeration of 28 species belonging to the Melampsoraceae.

**88. Studies on the Flax Rust.** Naohide HIRATSUKA. (Trans. Sapporo Nat. Hist. Soc. **10**, 1928, 1–27).

The flax rust which causes serious damage in Hokkaidô, the flax region in Japan, was the object of the author's investigations since several years. The causal fungus of the present disease is *Melampsora liniperda* (KÖRN.) PALM according to the author's opinion. In this fungus the spermatia are produced on septate branching spermatiophores, and the aecidium belongs to the typical *Caeoma*-type. Its uredosorus is covered by a parenchymatous peridium, as first observed by Ed. FISCHER. Teleutospores germinate in early spring, then after 6–10 days the spermogonia and after 10–17 days the aecidia are developed. According to the results of the author's inoculation experiments the period between the inoculation of uredo- or aecidiospores and the first appearance of new uredosori is 7–12, in average 9 days. It was further observed that there are strains which are immune or very resistant as well as susceptible to the rust.

**89. On the Fibrosin-body of Erysiphaceae.** (Japanese with an English summary). Yasu HOMMA. (Trans. Sapporo Nat. Hist. Soc. **10**, 1928, 47–61).

The authoress has examined conidia of a number of the Erysiphaceae, and could find always the fibrosin-body. The latter is soluble in conc. $H_2SO_4$, but insoluble in various acids and alcalies. It is not stainable with various staining reagents, but

stainable in methyl-blue+KOH and gentian-violet+NaHO. It is acted upon neither by pepsin nor by cytase and chitinase, but so by β-diastase. All chemical reactions, which were examined by the authoress are shown in two tables. From the results of the chemical experiments she concludes that the fibrosin-body seems to be a β-VI-carbohydrate containing N and may be designated as $(C_6H_{10}O_5)nNH_2$. The fibrosin-body generally assumes a certain definite shape, but not rarely it occurs in granular state. It is distributed in conidia, conidiophores, ascospores and mycelium.

**90. Revisio Graminum Japoniæ XV.** Masaji HONDA. (Bot. Mag. Tôkyô, **42**, 1928, 129–137).

In this paper are reported 1 new *Calamagrostis*-species, 4 new *Miscanthus*-species, 2 new *Poa*-species, 2 new *Festuca*-species, 4 new *Bromus*-species and 2 new varieties of *Miscanthus*.

They are as follows :

| | |
|---|---|
| *Calamagrostis kirishimensis*, HONDA | Kiusiu |
| *Miscanthus boninensis*, NAKAI | Bonin |
| *Miscanthus Nakaianus*, HONDA | Corea |
| *Miscanthus pycnocephalus*, HONDA | Kiusiu |
| *Miscanthus Kanehirai*, HONDA | Formosa |
| *Poa Hisauchii*, HONDA | Hondo |
| *Poa takeshimana*, HONDA | Corea |
| *Festuca formosana*, HONDA | Formosa |
| *Festuca eriantha*, HONDA | Kurile |
| *Bromus Tatewakii*, HONDA | Yezo |
| *Bromus formosanus*, HONDA | Formosa |
| *Bromus glabrescens*, HONDA | Kiusiu |
| *Bromus morrisonensis*, HONDA | Formosa |
| *Misanthus Matsudae* var. *glabrescens*, HONDA | Formosa |
| *Miscanthus pycnocephalus* var. *purpurascens*, HONDA | Kiusiu. |

Author.

**91. On *Cavicularia densa* Stephani.** Yoshiwo HORIKAWA. (Sc. Rpts. Tôhoku Imp. Univers. 4th Ser. (Biol.) **3**, 1928, 259–264, 1 pl. and 1 text-fig.).

The monotypic genus, *Cavicularia* contains a single species *C. densa* STEPHANI. Its sporophyte has never been described before. The author who was able to get its abundant materials describes and figures its sporophytic generation in detail. Its coincidence with *Blasia* is pointed out, especially the existence of a collar at the base of the capsules is characteristic of both *Cavicularia* and *Blasia*.

**92. Some Anatomical Notes on the Seedlings of *Pinus densiflora* and *P. Thunbergii*.** (Japanese with English résumé). Akira IIZUKA and Kin-ichi MORIKAWA. (Bult. Sc. Fak. Terk., Kjusu Imp. Univ. **3**, 1928, 49–59, 6 figs.).

The identification of seedlings of these two *Pinus* species which have just germinated according to certain anatomical characters is the subject of this paper. The cross-section of the cotyledon, its endodermis, the sclerenchymatous cell around the resin-canal of leaf, etc. are the characteristics for distinction.

**93. On some *Chaetoceras* of Japan. II.** Jiro IKARI. (Bot. Mag. Tôkyô **42**, 1928, 247–262, 13 figs.).

12 species and 1 variety of *Chaetoceras* are described, of which the following are new: *C. Okamurai, C. Okamurai* var. *tetraseta, C. compactum, C. Pavillardii, C. nipponica.*

**94. Über *Cladopus japonicus* n. sp., eine Podostemacee in Japan.** (Japanisch m. deutscher Zfg.). Shun-ichirô IMAMURA. (Jour. Japan. Bot. **5**, 1928, (50)-(62), 4 Abbild.).

Der Verf. beschreibt die Geschichte seiner Entdeckung einer Podostemacee in Japan (s. Japan. Jour. Bot. **4**, 1928, (7), Nr. 23), welche jetzt *Cladopus japonicus* n. sp. genannt wird, dann ausführlich die äussere Gestalt, den anatomischen Bau sowie den Blütenstruktur dieses eigentümlichen Gewächses.

**95. Cytological Studies on *Triticum* and *Aegilops* II. On the Genus Crosses between *Triticum* and *Aegilops*.** Fuyuwo KAGAWA. (Japan. Jour. Bot. **4**, 1928, 1–26, 7 pls.).

**96. Studies on the Regeneration in *Bryophyllum calycinum*.** Kinzirô KAKESITA. (Japan. Jour. Bot. **4**, 1928, 27–35, 3 text-figs.).

**97. Hybrid Vigor in *Solanum Melongena*.** (Japanese). Yôiti KAKIZAKI. (Agric. & Hortic. **3**, 1928, 371–380, 499–510).

By crossing several races of *Solanum Melongena* to each other the author could ascertain the more or less considerable hybrid vigor concerning various characters. The increase of seed weight in hybrids is 18.3% in average, in one case 79% larger than in the mother and in another 59% larger than in the father. Stems are in average 5.8% larger than the average of both parents. Their height is in average 6.4% larger than the average of both parents, and is nearly equal to that of the taller parent. The first harvest time is 3.1 days earlier than the average of both parents. The harvest, though very various in different combinations, is in average 36.1%, and in extreme case 152.0% higher than usual.

**98. The Chromosome Number in *Phaseolus* and *Allium*, and an Observation on the Size of Stomata in Different Species of *Triticum*.** Y. KATAYAMA. (Jour. Sc. Agric. Soc. No. **303**, 1928, 52–56, 8 figs.).

The chromosome number in some species of *Phaseolus* and *Allium* was determined. In the former the somatic number is 22, while in the latter the somatic and the reduced number are 16 and 8 respectively.

In several species of *Triticum* with 7, 14, and 21 chromosomes (reduced number) the size of stomata was measured. The relative size of stomata in 2X, 4X, and 6X species was 100:146:188, which accords practically with the results which SAX had formerly obtained.

**99. Serodiagnostic Investigation on the Affinities of Different Varieties of Rice.** (Japanese with English résumé). Shigemoto KATO and Yoshio MARUYAMA. (Bult. Sc. Fak. Terk., Kjuŝu Imp. Univ. **3**, 1928, 16–29).

The systematic relationship of various cereal crops was studied serodiagnostically by means of FORNET's "Ringprobe" and MISAO's "Absättigungsverfahren" for precipitin reaction.

According to the results of these investigations the three following classes are to be distinguished: 1. rice, *Setaria italica*, *Panicum crus-galli*, and maize, 2. *Eleusine Coracana*, and 3. barley and wheat. The rice varieties were distinguishable to each other by "Absättigungsverfahren." So those of Japan proper, China on one side and the native ones of Korea and Formosa on the other are clearly distinguishable from one another. Red and scented varieties from Japan proper are also distinguishable from the ordinary ones, while no difference at all is discernible between paddy and upland rice and also between glutinous and non-glutinous rice.

**100. Cytological Studies on *Iris*.** (Japanese with an English summary). Natsu KAZAO. (Bot. Mag. Tôkyô **42**, 1928, 262–266, 3 figs.).

The chromosome number in root-tips of several species in *Iris* was examined. It was various in different species and found to be 24, 28, 32, 36, 48, and 54 respectively. The reduction division of pollen mother-cells in these species was also studied. In the reduction division of *Iris florentina* and *I. japonica*, where the somatic chromosome number is 48 and 54 respectively, it was found that trivalent chromosomes are formed. These two *Iris* species should be autotriploid plants derived from those with 16 and 18 basic chromosomes respectively. It is very remarkable that such distinct species, as *I. florentina* or *I. japonica* have triploid chromosomes, and the fact reminds us of the possibility of the new species formation by the augmentation of the chromosome number.

**101. On the Chromosomes of *Humulus japonicus*.** (Japanese). Hitoshi KIHARA. (Bot. Mag. Tôkyô **42**, 1928, 237–238, 2 figs.).

The diploid chromosome number of *Humulus japonicus* is 17 in the male plant. One tripartite chromosome, which is probably the sex chromosome complex, and seven bivalents are found in the heterotypic metaphase. The three elements of the tripartite chromosome are divided transversally in the anaphase. One in the middle goes to one pole and the remaining two to the other pole. The behavior of the tripartite complex in quite the same as that in *Rumex acetosa* observed by KIHARA and ONO.

The chromosome numbers of root tips of some plants, whose sexes are not yet known, were counted. They were either 16 or 17. Author.

**102. New Aspects of Chromosome Behavior in Pollen Mother-cells of Tri-, Tetra- and Pentaploid Wheat Hybrids.** Hitoshi KIHARA and Ichizo NISHIYAMA. (Bot. Mag. Tôkyô, **42**, 1928, 221–231, 17 figs.).

(1) In the triploid wheat hybrids (A)×(A+B), *Triticum dicoccum* ♀ × *T. monococcum* ♂ and *T. aegilopoides boeoticum* ♀ × *T. dicoccum* ♂, we have found various modifications of the normal chromosome combination ($7_{II}+7_I$), namely there appears 0–3 trivalents and sometimes a bibivalent (not tetravalent) chromosome [$1_{II}+1_{II}$]. Table 1 shows the normal and modified combinations.

TABLE 1

| | | |
|---|---|---|
| $7_{II}$ | $+7_I$ | normal |
| $1_{III}+6_{II}$ | $+6_I$ | modification |
| $1_{III}+[1_{II}+1_{II}]+4_{II}$ | $+6_I$ | ,, |
| $2_{III}+4_{II}$ | $+7_I$ | ,, |
| $3_{III}+3_{II}$ | $+6_I$ | ,, |

(2)  In the tetraploid hybrid (A)×(ABD) between *T. spelta* and *T. aegilopoides boeoticum*, 0–3 trivalents were observed and sometime there are 0–3 bivalents from autosyndesis of chromosomes of B– and D– sets besides 7 normal bivalents (Tab. 2).

TABLE 2

| | | |
|---|---|---|
| $[1_{II} + 1_{II}]+5_{II}$ | $+14_I$ | modification |
| $1_{III}+ 5_{II}$ | $+15_I$ | ,, |
| $2_{III}+ 4_{II}$ | $+14_I$ | ,, |
| $1_{III}+ 7_{II}$ | $+11_I$ | ,, |
| $10_{II}$ | $+ 8_I$ | ,, |
| $7_{II}$ | $+14_I$ | normal |

Triploid and tetraploid hybrids were weakly fertile (Tab. 3.).

TABLE 3

| Hybrids | 1st & 2nd florets | grains | % |
|---|---|---|---|
| *T. aegilopoides×dicoccum* | 1214 | 0 | 0.000 |
| *T. dicoccum×aegilopoides* | 2404 | 2 | 0.083 |
| *T. aegilopoides×turgidum* | 1980 | 1 | 0.050 |
| *T. turgidum×aegilopoides* | 2592 | 6 | 0.231 |
| *T. spelta×aegilopoides* | 3064 | 15+1* | 0.489 |

* One grain obtained from a third floret

(3)  We saw the normal chromosome combination $14_{II}+7_I$ in nearly all the cases of *T. durum×T. vulgare* (A+B)×(A+B+D), and 1–2 trivalents rarely (Tab. 4).

TABLE 4

| | |
|---|---|
| $13_{II} + 9_I$ | rare |
| $14_{II} + 7_I$ | common |
| $1_{III} +13_{II}+6_I$ | |
| $2_{III} +12_{II}+5_I$ | |

(4)  The relationship among the chromosomes of 3 different sets, A, B and D may be given as follows :



A–3–B means that 3 chromosomes from A– and B– sets have affinity to conjugate.

Authors.

Entry  102 (Continued)
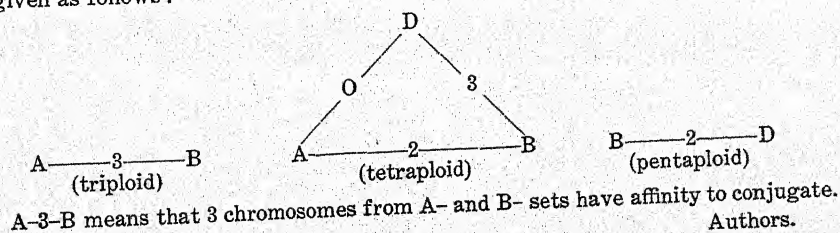
**103. Über Toisusu, eine neue Salicaceen-Gattung und die systematische Stellung derselben.** (Japanisch mit lateinischen Diagnosen). Arika KIMURA. (Bot. Mag. Tôkyô **42**, 1928, 287–290).

Eine neue Salicaceen-Gattung, *Toisusu* wird ausführlich beschrieben. Die folgenden Art und Varietäten, die bisher unter *Salix* eingereiht worden sind, gehören dazu: *Toisusu cardiophylla*, var. *Schneiderii*, var. *Urbaniana*, var. *Maximowiczii*. Das folgende System der Salicaceen wird angegeben:

Subfam.  I.  Populoideae ..................... *Populus*
Subfam.  II.  Salicoideae
    Tribus  I.  Chosenieae ............. *Chosenia*
    Tribus  II.  Saliceae
        Genus  I. ................. *Toisusu*
        Genus  II. ................. *Salix*
                Subgenus  I.  Protitea
                Subgenus  II.  Euitea

**104. Drei neue Arten von Leuchtbakterien.** Teijiro KISHITANI. (Proc. Imp. Acad. **4**, 1928, 69–72, 6 Abbild.).

*Pseudomonas luminescens* und *P. photogena* aus einem leuchtenden Tintenfische und *P. phosphorescens* aus einer leuchtenden Sardine. Bei jeder Art sind die morphologischen sowie physiologischen Charaktere ausführlich beschrieben.

**105. Über das Leuchtorgan von Euprymna morsei Verrill und die symbiotischen Leuchtbakterien.** Teijiro KISHITANI. (Proc. Imp. Acad. **4**, 1928, 306–309, 5 Abb.).

Aus dem leuchtenden Tintenfische, *Euprymna morsei* wird eine neue damit im Symbiose lebende leuchtende Bakterienart, *Pseudomonas Euprymna* isoliert. Die Reinkultur wurde ausgeführt. Ihre morphologische sowie kulturelle Verhalten wird ausführlich beschrieben.

**106. Emendation of the Scientific Name of "Tsukushi-Podostemon."** Gen-ichi KOIDZUMI. (Jour. Japan. Bot. **5**. 1928, 1–2.).

To a new species of Japanese Podostemaceae—Japanese name "Tsukushi-Podostemon"—discovered recently and named *Lawiella Doiana* a new name, *L. japonica* was given. Its Latin diagnosis is added.

**107. On the Relation between Cell-division and Elongation in the Root of Vicia Faba.** Hitoshi KOJIMA. (Jour. Dept. Agr. Kyushu Imp. Univ. **2**, 1928, 75–91.).

The elongation rate of the growing point in the root of *Vicia Faba* at intervals of about from 1/2 to 2 hours under constant conditions of illumination, temperature and moisture was measured throughout a 24-hour period. At the same time the number of dividing cells in the sections of the root tips of the material at the same intervals and under the same conditions was counted. From these observations the author concludes as follows. There is a daily periodicity in the rate of cell-division. The curves indicating the variation of this rate are not always similar according to the differences in material and condition, but there is a certain definite curve for each kind of material under the same conditions, which shows two maxima. The rate of elongation proceeds in a rhythmical manner. In accordance with the material and

condition, the maximum and minimum do not always occur at a fixed time of day, but they have some regular length of period, because the resting phase of 8 hours follows the active phase of 16 hours. The primary active phase in cell-division nearly coincides with the resting phase in the elongation, but the secondary maximum is accompanied by no recognizable resting phase in the elongation. However the active phase in elongation occurs several hours after the maximum point of primary active phase in cell-division has been attained.　　　　　　　　　　　　Author.

**108. Variation of the Water Content of Leaves in Relation to the Wilting of Plants.** Riichiro KÔKETSU. (Proc. Imp. Acad. Tokyo, **4**, 1928, 229-230.). See the next No.

**109. Variation of the Water Content of Leaves as Related to the Wilting of Plants.** Riichiro KÔKETSU. (Jour. Dept. Agr. Kyushu Imp. Univ. **2**, 1928, 93-116.).

The variation of the foliar water content in relation to the wilting of plants was studied by determining the water content at the critical stages of wilting of leaves, *Coleus Blumei, Glycine Soja* and *Mimosa pudica* being used as the materials for experiments. The consideration of results was made principally on the basis of the amount of water contained in the unit area of the leaf. But in the case of *Mimosa*, the percentage values on the basis of the dry weight was adopted. By the way the water content per unit volume of the tissue powder was also determined with a good applicable result.

The water content of each plant seemed to be very similar at a given critical stage of wilting, though the value was affected not a little by the culture conditions. But the water content in question was found to be very different to each other in different plants. The ratio of the critical water content to the content at the stage of full turgidity is also very various. The value of this ratio was proved to be much higher in *Coleus* than in the other two materials, while the values for these latter two were found to be near to each other. Therefore this ratio seemed to be specific to a given plant; it will show the degree of the resisting power of a plant against wilting, and the value in question will serve as an index for comparing the degree of the xerophytism of plants, in as much as the more xerophytic a plant, the lower is it.　　　　　Author.

**110. Über den Effekt der Anwendung der „Pulvermethode" für die Bestimmung des Stoffgehaltes im Pflanzenkörper. II. Vergleichende Bestimmung des Trockensubstanz- und Aschengehaltes der Samen.** (Japanisch mit Deutsch. Zfg.). Riichiro KÔKETSU und Sadayoshi FUKAKI. (Bult. Sc. Fak. Terk. Kjuŝu Imp. Univ. **2**, 1927, 273-283.).

In diesem Aufsatz haben die Verfn. die Vorzüglichkeit der „Pulvermethode" KÔKETSUS für die Bestimmung des relativen Trockensubstanzgewichtes und des Aschengehaltwertes verschiedener Samen an der Basis einiger Beispiele gezeigt. Die Tatsache, dass die Resultate solcher Bestimmungen zueinander nicht übereinstimmen, je nachdem sie nach den verschiedenen üblichen Verfahren oder der „Pulvermethode" vorgenommen werden, ist nach den Verfn. darauf zurückzuführen, dass während die ersteren ausser dem Bestimmungsfehler eine oder andere ignorierte Fehlerquelle enthalten, die letztere von solchen fast frei ist.

Das Trockengewicht des Pulvers verschiedener Samen oder Geweben pro 1 ccm, das dem spezifisches Gewicht ihrer Trockensubstanz darstellt, wird als „spezifisches Pulvergewicht" bezeichnet. Wenn es kein echtes spezifisches Gewicht des Pulvers mag, so doch muss es viel bedeutsamer als das sog. spezifische Gewicht der Samen, das gewöhnlich unter Ignorierung der Gewebedichte bestimmt wird. (Vgl. Japan. Jour. Bot. **3**, (90), Nr. 266).

**111. Über den Effekt der Anwendung der „Pulvermethode" für die Bestimmung des Stoffgehaltes im Pflanzenkörper. III. Vergleichende Bestimmung des „spezifischen Pulvergewichtes" an den Samenkörnern von verschiedenen Reispflanzensippen.** (Japanisch mit Deutsch. Zfg.). Riichiro KÔKETSU und Hirosi KOSAKA. (Bult. Sc. Fak. Terk., Kjusû Imp. Univ. **3**, 1928, 35–48).

Es wurde das „spezifische Pulvergewicht," d. h. das Trockengewicht pro 1 ccm. Gewebepulver der von Spelzen befreiten Samen verschiedener Reispflanzensippen nach der KÔKETSUschen „Pulvermethode" bestimmt. Es ergab sich dabei :

1. Das spezifische Gewicht der Samenkörner nimmt allmählich mit dem Fortschritte der Reifung zu.—2. Bei reicher Düngung ist das spezifische Gewicht der Samenkörner kleiner als ohne oder bei armer Düngung.—3. Bei der Kultur im mit Seewasser bewässerten Felde ist das spezifische Gewicht der Körner niedriger als bei derselben im normalen.—4. Eine und derselbe Sippe zeigt verschiedene spezifische Gewichte, wenn sie in verschiedenen Distrikten gezüchtet wird, während verschiedene an demselben Orte kultivierte Sippen sich nicht anders verhalten.

**112. Über den Ort der in dem Wurzelspitzengewebe von *Vicia Faba* gebildeten Röntgengeschwülst.** (Japanisch und Deutsch). Hideo KOMURO. („Gann," Nipponische Zeit. Krebsforsch. **22**, 1928, 41–62, 1–14, 2 Taf.).

Mittelst der schwachen RÖNTGENbestrahlung hat PEKAREK in der Wurzel von *Vicia Faba* die Gewebeabnormität, „Insel" entstehen lassen und er ist zum Schlusse gekommen, dass sie die Anlage einer Nebenwurzel sei, die im Perizykel ihren Ursprung nahm und von den Zellen der noch undurchbrochenen Endodermis eingeschlossen ist. Daraus halte P. es nicht für unwahrscheinlich, das die RÖNTGENgeschwülste KOMUROS die Nebenwurzelanlagen verbergen. Der Verf. kann nicht dabei PEKAREK beistimmen und schildert seine dazu entgegengesetzte Ansicht.

**113. Über die in der Landwirtschaft Japans gebrauchten Samen.** (Siebente Mitteilung). Mantarô KONDÔ. (Ber. Ôhara Inst. landw. Forsch. **3**, 1928, 457–495, 14 Textabb.).

Betreffs *Fagopyrum esculentum, F. tataricum,* einige andere *F.*-Arten, *Polygonum tinctorium, Rheum rhaponticum, Rumex acetosa, Panax Ginseng, Papaver somniferum* sind die äusseren Merkmale der Früchte oder Samen, der anatomische Bau (Schale, Endosperm, Embryo) sowie die Keimpflanzen ausführlich beschrieben.

**114. On the Development of the Sexual Organs and Embryogeny in *Sargassum Horneri* Ag.** Hiroshi KUNIEDA. (Jour. Coll. Agric. Imp. Univ. Tokyo **9**, 1928, 383–396, 3 pls. and 2 text-figs.).

S. Japan. Jour. Bot. 1927, (90), No. 267.

**115. An Occurrence of Restitution-Nuclei in the Formation of the Embryo-sacs in *Balanophora japonica*, Mak.** Yoshinari KUWADA. (Bot. Mag. Tôkyô **42**, 1928, 117–129, 2 pls. and 1 text-fig.).

In this paper an occurrence of restitution-nuclei in the formation of the embryo-sacs in *Balanophora japonica* has been reported. The number of chromosomal elements found on the equatorial plate of the heterotype division varies from 94 to 112 so far as the present investigations are concerned. There is a correlation between the number of these elements and their sizes. These facts seem to show that at least in some of the chromosomes there is a tendency to form gemini, but the number of such chromosomes varies in different embryo-sac mother-cells. The chromosome number in somatic cells seems to be not far from the largest number counted in the heterotype division, 112. The probable cause of the abnormalities observed has been briefly discussed.                                                     Author.

**116. The Effect of Renewal of Nutrient Solutions upon the Growth of Culture Plants and its Relation to Aëration.** Tsung-Lê LOO. (Japan. Jour. Bot. **4**, 1928, 71–98, 5 text-figs.).

**117. The Spiral Structure of Chromosome in Sweet-pea (*Lathyrus odoratus*).** Takeshige MAEDA. (Bot. Mag. Tôkyô, **42**, 1928, 191–195, 1 pl.).

With certain fixatives the spiral structure of chromosomes was clearly observed practically throughout all the stages from the late prophase of heterotype division up to the formation of the tetrad nuclei. In the interkinesis no anastomoses take place between chromosomes, but each individual coiled chromosome can be clearly traced throughout the stage. In young tetrad nuclei chromosomes present the same coiled appearance as those found in the interkinesis.

The double spiral of the heterotype metaphasic chromosomes as described by other authors was not observed in this plant but it seems to be highly possible that an appropriate method of treatment will disclose the same nature of the spiral in the heterotype metaphase in the sweet-pea too.                                               Author.

**118. Notulæ ad Plantas Japoniæ & Koreæ XXXV.** Takenoshin NAKAI. (Bot. Mag. Tokyo, **42**, 1928, 1–26).

This paper refers to the following plants.

1. *Thalictrum kiusianum* NAKAI, a new species found in Kiusiu
2. *Thalictrum daisenense* NAKAI, a new species found in West Hondo
3. *Thalictrum Thunbergii* A.P. DE CANDLLE.

The last is *Thalictrum minus* of East Asia. The author saw the type-specimen of this species at Herbier DELESSERT, and the type- and co-type-specimens of allied species : *T. minus, T. majus, T. elatum, T. kemense* at the Herbarium of Paris Museum, and gave the analytical key. He distinguishes the following varieties and forms in the Japanese and Korean specimens :

*T. Thunbergii* var. *hypoleucum* KAKAI (*T. hypoleucum* SIEB. & ZUCC.)
*T. Thunbergii* var. *hypoleucum* f. *rotundifolium* NAKAI
*T. Thunbergii* var. *majus* NAKAI
*T. Thunbergii* var. *majus* f. *variegatum* NAKAI
*T. Thunbergii* var. *majus* f. *leucanthum* NAKAI
*T. Thunbergii* var. *tenuipes* NAKAI
*T. Thunbergii* var. *divaricatum* NAKAI

Entries  115–118

(42)

T. *Thunbergii* var. *contractum* NAKAI

T. *Thunbergii* var. *condensatum* NAKAI.

4. *Thalictrum yesoense* NAKAI, a new species growing in Yeso, which was hitherto mistaken for *Thalictrum minus* var. *nanum.*

5. *Trollius Riederianus* FISCHER & MEYER, newly found in the Kuriles and Yeso.

6. T. *japonicus* MIQUEL, newly found in the Kuriles and Korea.

7. T. *japonicus* f. *pedunculatus* NAKAI, new to the Flora of the Kuriles.

8. T. *hondoensis* NAKAI, a new species found in Japanese Alps.

9. T. *macropetalus* Fr. SCHMIDT, new to the Flora of Yeso.

10. *Rubus microphyllus* LINNÉ fil.

The author saw the type specimen of the last at the Linnaean Society of London, and found that it is conspecific with *Rubus incisus* THUNBERG ; the latter was published three years later than that.

11. *Gentiana scabra* var. *intermedia* KUSNEZOFF, new to the Flora of Quelpaert.

12. *Senecio cannabifolius* LESSING and *Senecio palmatus* PALLAS.

The author pointed out the specific differences of these two species, though they are generally misunderstood to be one and the same species at present.

13. *Adenophora hakusanensis* NAKAI, a new species found in Hondo.

14. Three varieties and a form of *Conandron ramondioides*

　　*a.* var. *typicum* NAKAI

　　*b.* var. *pilosum* NAKAI

　　*c.* var. *pilosum* f. *variegatum* NAKAI

　　*d.* var. *leucanthum* NAKAI.

15. *Ixeris dentata* var. *atro-purpurea* NAKAI, a new variety found in Hondo.

16. *Solidago Virgaurea* L. var. *praeflorens* NAKAI, a new variety found in the island of Hachijo; var. *asiatica* NAKAI, new name proposed for East-Asiatic variety ; var. *alpina* BIGELOW, new to the Flora of Japan ; var. *yakusimensis* NAKAI, a new variety found in the island of Yakushima; var. *gigantea* NAKAI, a new variety found in Yeso.

17. *Alnus tinctoria* var. *microphylla* NAKAI, a new variety found in Hondo.

18. *Betula latifolia* var. *cuneifolia* NAKAI, a new variety found in Hondo.

19. *Fagus crenata* var. *grandifolia* NAKAI, a new variety found in Hondo.

20. *Bistorta vivipara* f. *ramosa* NAKAI, a monstruous form common at Kamikôchi of Central Hondo.

21. *Rumex pratensis* MERTENS & KOCH, new to the Japanese Flora.

22. *Rumex Hydrolapathum* HUDSON, new to the Japanese Flora.

23. *Rumex aquaticus* LINNÉ, new to the Japanese Flora.

24. *Aconitum paludicola* NAKAI, a new species found in Hondo.

25. *Ranunculus nipponicus* NAKAI, a new species of section *Batrachium* found in Central Japan.

26. *Ranunculus Vernyi* FRAN. & SAV. var. *glaber* NAKAI & var. *japonicus* NAKAI

The former is the type of this species, the latter hairy variety is one type of *Ranunculus ternatus* THUNBERG sent by him to DELESSERT, and figured by DELESSERT in his Icones Selectae Plantarum I.

*Ranunculus Vernyi* var. *quelpaertensis* NAKAI, a slender variety growing in Quelpaert and Japan.

*Ranunculus Vernyi* var. *prostratus* NAKAI, a radicant variety ! Two species are kept in the Herbier DRAKE DEL CASTILLO of Paris Museum.

Entry 118 (Continued)

27. *Ranunculus Zuccarini* MIQUEL

this is another type of *Ranunculus ternatus* THUNBERG which THUNBERG kept for himself and later figured in his paper.

28. *Ranunculus repens* LINNÉ var. *major* NAKAI

this is an Asiatic variety, differing from the European type by bigger and more glabrous stem, and larger leaves.

29. *Ranunculus flagellifolius* NAKAI, a new species growing in Middle Hondo.

30. *Ranunculus lutchuensis* NAKAI, a new species found in Liukiu.

31. *Cardamine senanensis* NAKAI (erroneously written as *nipponica*), a new species found in Central Japan.

32. *Cardamine valida* NAKAI.

The author raised *C. prorepens* f. *valida* TAKEDA to the specific rank.

Author.

**119. Notes on Japanese Ferns VII.** Takenoshin NAKAI. (Bot. Mag. Tokyo **42**, 1928, 203–218, 4 figs.).

This contains the following items.

1). A revision of Japanese Plagiogyriaceae, in which seven species are enumerated. The author distinguishes them into two sections (Polyneumatophorata & Paripneumatophorata) by the numbers and position of pneumatophores. *Plagiogyria formosana* and *P. japonica* are new species.

2). Proposal of a new family Cheiropleuriaceæ for the genus *Cheiropleuria*, founded on the construction of stele, development of stomata, form of hairs and sporangia.

3). Japanese Dipteridaceæ.

4). Description of a new genus *Neoniphopsis* based on *Niphobolus linearifolius*.

5). A new combination *Dryopteris acuminata* out of *Polypodium acuminatum*. This name is adopted by the author for *Polypodium sophoroides* or *Dryopteris sophoroides*. He saw the type specimen of the latter at Upsala University and found that they belong to one and the same species.

Author.

**120. Wirkung des der Luft entleerten Wassers auf die Wasseraufnahme verschiedener Körper.** Yôzô NAKAJIMA. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. (Biol.) **3**, 1928, 279–298, 14 Abbild.).

Der Verf. hat für seine Experimente der Wasserabsorption durch eine Anzahl von Objekten, hauptsächlich pflanzlichen, luftfreies oder luftenhaltendes Wasser gebraucht und den Unterschied der aufgenommenen Wassermenge in beiden Fällen entweder volumetrisch oder gravimetrisch bestimmt. Die Versuchsobjekte waren die folgenden : Blatt von *Commelina nudiflora*, Fruchtschale von *Citrus aurantium* subsp. *sinensis*, Hölzer aus *Paulownia*, *Actinidia*, *Castanea*, *Osmanthus*, Reiskörner, Samen von *Nuphar japonicum*, geschnittene Sprosse bzw. Blätter von *Liriodendron*, *Lespedeza*, *Althaea*, *Ligularia*, Gypsblöckchen. Es wurde dabei festgestellt, dass im Falle wenn man luftleeres Wasser gebraucht, die aufgenommene Wassermenge grösser, und zwar gewöhnlich bedeutend grösser ist als wenn man lufthaltendes Wasser verwendet. Die Tatsache ist leicht begreiflich, wenn man bedenkt, dass luftfreies Wasser seinen Weg versperrende Luft weit begieriger als bei lufthaltigen lösen und somit schneller und in grosser Menge in den pflanzlichen und anderen Körper eindringen kann.

Entries 119–120

**121. Über das Vorkommen kleiner embryonaler Körperchen in der Frucht von *Crinum latifolium*, L.** Yôzô NAKAJIMA. (Sc. Rpt. Tôhoku Imp. Univ. 4th Ser. (Biol.) **3**, 1928, 431–442, 2 Taf. u. 2 Textfig.).

Die grossen fleschigen Samen von *Crinum latifolium* können als knollenförmig bezeichnet werden. Der Verf. fand in der Frucht dieses Gewächses neben solchen fleischigen Samen keulenförmige Körperchen von 0.5—10.0 mm Grösse, welche besonders im Falle der Selbstbefruchtung reichlich produziert werden. Die letzteren, welche der Verf. embryoförmige Körperchen nennt, entstehen aus den Samenanlagen. Wenn man sowohl sie als die Embryonen aus normalen Samen in der Zuckerlösung von einem gewissen Prozent ernährt, wachsen beide in ähnlicher Weise. Auch wenn man in einem Samen ein kleines Loch macht und dieses Körperchen darin hineinsteckt, kann man sehen, dass es auf Kosten des Endosperms des Samens langsam wachsen kann. Dem Verf. gelang es jedoch nicht, es zu einer selbständigen Pflanze entwickeln zu lassen, was leicht begreiflich sein dürfte, weil es weder Reservestoffe für seine Ernährung noch keinen Schutz gegen Austrocknen besitzt.

**122. On *Septoria Callistephi* Gloyer parasitic on *Callistephus chinensis*.** (Japanese). Hisao NAKAMURA. (Jour. Microbiol. Soc. Japan **22**, 1928, 12 pp., 3 figs.).

The behaviour of *Septoria Callistephi* (s. Japan. Jour. Bot. **3**, (62), No. 175.-Ed.) on various nutrient media was studied. The best growth takes place between ±20°–±28° C. Inoculation experiments were performed with success. On one and the same medium the colonies which are salmon-orange and those which are blackish gray were produced. The author takes the latter colour for the proper one of the fungus and considers the salmon colour due to the new mycelia produced by mutation. The constancy of the colour of the mutant was confirmed by repeated cultures. (S. Japan. Jour. Bot. **4**, (17), No. 45).

**123. Diseases of Cultivated Plants in Korea.** (Japanese). Kakugorô NAKATA and Seitô TAKIMOTO. (Jour. Agric. Exp. Sta., Govern. General of Chosen, No. **15**, 1928, 46 pp. text, 10 pp. index, 34 pls.).

The symptoms of diseases of cereals, legumes, fruit-trees, and various other plants for special use cultivated in Korea are described, together with the causal organisms. Each case is accompanied by illustrations.

**124. Some Cytological Observations in *Tricyrtis*, *Sagittaria*, and *Lilium*.** Nagamitu NAWA. (Bot. Mag. Tôkyô **42**, 1928, 33–36, 1 pl. and 1 text-fig.).

In the microcytes of *Tricyrtis hirta*, *T. formosana*, *T. stolonifera*, and *T. macropoda* 13 chromosomes were found, two of which are larger than the others. The somatic number, as found in root-tip cells is 26, of which 4 are larger than the others. Various stages of nuclear division are described and figured. The crosses, *T. hirta* × *T. stolonifera*, and *T. hirta* × *T. formosana* and their reciprocals are studied cytologically. In these crosses the behaviour of chromosomes is irregular. There are both bi- and univalent chromosomes, of which the former are in the number of 7–8.

In *Sagittaria sagittifolia* forma *sinensis* the root-tip cell shows 20 chromosomes, of which some have subterminal constrictions.

<div align="center">Entries 121–124</div>

In the microcytes of *Tricyrtis* the extrusion of the nuclear substance has been observed till now simply in the prophases, especially in synapsis stage. In *Lilium Henryi* (?) the author could observe the same phenomenon in the metaphase and anaphase of the first meiotic division.

**125. On Hybrids between *Triticum spelta* and Dwarf Wheat Plants with 40 Somatic Chromosomes.** (Japanese with an English résumé). Ichizo NISHI-YAMA. (Bot. Mag. Tôkyô **42**, 1928, 154–177, 4 figs.).

We have found 20 bivalents and 1 univalent in the meiosis of the PMC of the $F_1$ hybrids between *Triticum spelta* ($42 = 21_{II} + 0_I$) and two dwarf wheats (D–$2g$ and D–$2f$, $40 = 2C_{II} + 1_I$). From the „Äquationskreuzung" ($F_1 \times$ parents) the occurrence of 20- and 21- chromosome megaspores has been determined in a ratio 400:150 in (D–$2g$ × *T. spelta*) $F_1$, and 84:34 in (D–$2f$ × *T. spelta*) $F_1$. On the other hand by the „Zerta-tionskreuzung" (Parents × $F_1$) the proportion of fertilized 20- and 21- chromosome microspores has been found to be 71:562 in the former, and 66:111 in the latter. If the above mentioned gametophyte ratios are effective in selfed $F_1$ plants we should expect 40-, 41- and 42- chromosome progenies to be 8:68:24 in (D–$2g$ × *T. spelta*)$F_2$, and 27:56:17 in (D–$2f$ × *T. spelta*)$F_2$. The calculated ratios are in close agreement with the observed ones, i. e. 140:879:255 in the former, and 90:446:111 in the latter. Among $F_2$ progenies there was some plants with unexpected chromosome combinations and various chromosome numbers; and among them a plant with a non-viable combina-tion, $19_{II} + 1_I$, was found to be most sterile. Although the fertility of a selfed D–$2g$ is as low as 56 per cent, male and female gametes are effective more than 83 per cent even in artificial pollination.

The allelomorphic characters for awns and hairs on glumes are transmitted by two different simple Mendelian factors which do not lie in the *g*- or *f*- chromosome.

<div align="right">Author.</div>

**126. The Nicotine Content in Fresh Tobacco Leaves.** (Japanese with English résumé). Shoji NISHIYAMA. (Bult. Sc. Fak. Terk., Kjuŝu Imp. Univ. **3**, 1928, 10–15).

It was found on green tobacco leaves that their nicotine content increases gradually from the lower towards the higher ones.

**127. Leaf Blight of *Eragrostis major* Host, Caused by *Ophiobolus Kusanoi* n. sp., the Ascigerous Stage of *Helminthosporium*.** Yosikazu NISIKADO. (Japan. Jour. Bot. **4**, 1928, 99–112, 5 pls.).

**128. On the Systematic Importance of the Spodiograms of Leaves of the Bambusaceae (II-III).** (Japanese). Kiichi OHKI. (Bot. Mag. Tôkyô **42**, 1928, 270–278, 311–317, with figs.).

This is the continuation of the author's classification of the Bambusaceae accord-ing to their " Aschenbild." (S. Japan. Jour. Bot. **4**, 1928, (21), No. 57). The follow-ing species of *Sasa* are treated of: *Sasa Hayatae, Makinoa, nipponica, Veitchii, Hisauchii, kiusiana, kurilensis, nebulosa, nana, stenantha,* and *senanensis.*

**129. On the Root-pressure of *Cornus controversa*, observed at Sendai.** (Japanese). Yônosuke OKADA. (Bot. Mag. Tôkyô **42**, 1928, 218–221, 1 fig.).

<div align="center">Entries 125–129</div>

The root-pressure was registered by a certain automatic apparatus in April 1926-7, and the following facts were ascertained.

There are the daily maximum and minimum. The time interval between the maximum and the minimum is shorter than that between the latter and the following maximum. The maximum and the minimum of root-pressure were found to stand just in opposite relation to those of temperature, because the maximum and the minimum of the former are very near located to the minimum and the maximum of the latter respectively. The fact is easily intelligible, since the intensity of root-pressure depends on the absorptive capacity of roots and the transpiring power of aerial parts.

**130. Study of *Euryale ferox* Salisb. I. On the Size of Leaves, Fruits, etc. with Some Remarks on the Mode of Expansion of the Leaf-blade.** Yônosuke OKADA. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. (Biol.) **3**, 1928, 271–278, 2 pls. and 4 text-figs.).

*Euryale ferox* is characterized by its gigantic leaves. Especially those in Zyûni-tyôgata (a kind of tidal basin of the river Mao in the Toyama Prefecture) are known to produce much larger leaves than those found in other localities. The largest one till now measured is 272 cm. in its diameter, and larger than that of *Victoria regia* measuring 7 ft. (=200 cm). The cells composing such leaves are not however especially large, the width of the palisade-cell being in average 17.8 µ, which nearly corresponds to what AMELUNG has observed in *Victoria regia* and *Nymphaea alba* (=0.0197 and 0.019 mm. respectively).

The size and weight of fruits and seeds were also measured, and the results are given in a table.

The stem which is imbedded in the mud of the bottom is short and wide. Leaves originate on it as mere elevations. The differentiation into blade and petiole becomes soon discernible. The edge of the young blade which is still under water is bent over its surface towards the center, and resembles a human fist externally. On the arrival at the water surface the blade begins to unfold, taking first a cup-like shape and then becoming more and more flat.

**131. Algae from Kamtschaka.** Kintarô OKAMURA. (Records Oceanogr. Works in Japan, Tokyo, 1, 1928, 52–55, 3 pls. and 1 text-fig.).

The following Laminariaceae from Kamtschaka are recorded : *Ptilota asplenioides* (TURN.) AG., *Odonthalia dentata* (L.) LYNGB., *Alaria ochotensis* YENDO, *Agarum Turneri* P. et R., *Laminaria longipes* BORY, *L. palmaeformis* (n. sp.), *Hedophyllum spirale* YENDO (?).

**132. Icones of Japanese Algae.** Kintarô OKAMURA. Vol. V, No. 10, 1928, 181–201, 5 pls. (Japanese and English).

In this number the following algae are contained : *Platoma japonica* OKAM. sp. nov., *Dumontia simplex* COTTON, *Gigartina ochotensis* RUPR., *Pelvetia Wrightii* (HARV.) YENDO, *Sargassum nipponicum* YENDO, *Letterstedtia japonica* HOLM , and *Spongocladia vaucheriaeformis* ARESCH.

The diagnosis of *Platoma japonica* n. sp. runs as follows : Frond flat, gelatinous, broadly linear, high, 2-3 times alternately branched, divided into some main branches with erecto-patent axils, and having deltoideo-linear or often elongated, ultimate lacineae. Cystocarps minute dot-like.                          Author.

**133. Embryologische Studien an einigen Pontederiaceen.** Tomowo ONO. (Sc. Rpts. Tôhoku Imp, Univ. 4th Ser. (Biol.) **3**, 1928, 405–415, 2 Taf. u. 4 Textfig.).

Bei *Monochoria Korsakowii* und *vaginalis* geht die Embryosackbildung ganz normal vor sich ; Doppelbefruchtung wurde beobachtet. Bei der Endospermbildung wird nach der ersten Teilung des primären Endospermkernes der Embryosack in zwei ungleichgrossen Kammern geteilt, und zwar mit einer Scheidewand zwischen ihnen. Aus der Basis der oberen Kammer sind zwei laterale Haustorien produziert, die sich durch Aufbrauchen des Nuzellusgewebes in die Chalazagegend ausdehnen. Indessen verlängert sich die obere Kammer zwischen den zwei Haustorien, welche bald degenerieren. Das Endosperm besteht hauptsächlich aus dem durch die Entwicklung der oberen Kammer gebildeten Zentralendosperm.

Bei *Eichhornia crassipes* kommt keine Scheidewand zwischen zwei nach der ersten Teilung des primären Endospermkernes gebildeten Kammern vor. Die Samenanlagen degenerieren bald und keine Haustorienbildung wird beobachtet.

**134. Triploid and Tetraploid Intersex in *Rumex Acetosa*, L.** (Japanese with an English résumé). Tomowo ONO and Naomasa SHIMOTOMAI. (Bot. Mag. Tôkyô **42**, 1928, 266-270, with figs.).

As is already known (KIHARA and ONO, 1923, 1925), the diploid number of chromosomes of *Rumex Acetosa*, L. is $15(=12a+X+2Y)$ in the male and $14(=12a+2X)$ in the female. The authors have investigated the diploid numbers of chromosomes of a number of intersexual plants, which are found sometimes growing wild. Mostly they are 22 (triploid) and in one case 29 (tetraploid). The formulae of these chromosomes should be perhaps, as follows :

$$22=18a+2X+2Y$$
$$29=24a+3X+2Y$$

Large, equal-armed, V-shaped X-chromosomes can be identified usually with no difficulty. The intersexual plants should have arisen therefore from the union of the diploid and haploid or both diploid gametes, the intersex being caused by the broken balance between the autosomes and sex-chromosomes. Authors.

**135. Discovery of Gametophyte of *Archangiopteris Somai* Hay.** (Japanese). Syun'iti SASAKI. (Bot. Mag. Tôkyô **42**, 1928, 233–236 with figs.).

The prothallium of *Archangiopteris Somai* discovered in a certain high region (720 m above sea-level) of Formosa is described and figured. It is flat and disc-shaped, $8$–$20 \times 10$–$16$ mm, with wavy and much folded border, monoecious.

**136. On the Formation of Proembryo of *Ginkgo biloba*.** (English and Japanese). Tamaki SHIMAMURA. (Bot. Mag. Tôkyô **42**, 1928, 71–82, 2 pls.).

In the fertilization of *Ginkgo biloba* the sperm enters the receptive cavity in the upper part of the egg, and only the sperm-nucleus can march deeply into the egg-cytoplasm, the cilia-bearing cytoplasmic sheath being left near the outer boundary of egg-cytoplasm. The second division of the fertilized nucleus is intra-nuclear, and the mitotic figure is large. The spireme of the third division gives convoluted appearance, and lies at one side of the nucleus. The formation of proembryo takes place according to a regular series of mitoses, and the divisions are strictly simultaneous up to the 64-nucleate stage. HERZFELD has described a peculiar mode of nuclear division which she calls " Protomitose," and she was not able to find any

mitotic figure. The author of this paper, on the contrary, has found mitotic figures and could find neither amitosis nor protomitosis, which, according to the author's view, may not be considered as normal processes.

S. HERZFELD's note in Jahrb. wiss. Bot. **67**, 1928, 981.-Ed.

**137.  On the Chromosome Number and the Unequal Pair of Chromosomes in Some Dioecious Plants.**  Yosito SINOTÔ. (Proc. Imp. Acad. **3**, 1928, 175–177, 21 figs.).

The haploid number of chromosomes in the male of the dioecious plants mentioned below was determined. In all cases one geminus consisting of an unequal pair of chromosomes was found. The plants studied are as follows: *Morus bombycis, Cannabis sativa, Cudrania triloba, Datisca cannabina, Daphniphyllum macropodum, Trichosanthes japonica,* 5 species of *Salix, Trachycarpus excelsa* var. *Fortunei.*

**138.  Pollen Development of *Jussieua repens,* L.**  Yosito SINOTÔ. (Proc. Imp. Acad. **3**, 1928, 231–232, 10 figs.).

In the microcytes of *Jussieua repens* the number of caryotin granules which are recognizable in the synaptic stage is never constant, and does correspond neither to the haploid nor diploid chromosome number. The haploid number is 8, which differs from what was observed till now in the other Oenotheraceae. Pollen-tetrads seem to be formed by the furrowing method.

**139.  Chromosomes of *Hydrilla verticillata* Pres.**  (Japanese with an English summary).  Yosito SINOTÔ and Kogane KIYOHARA. (Bot Mag. Tôkyô **42**, 1928, 82–85, 4 figs.).

The diploid chromosome number of *Hydrilla verticillata* is 24. Chromosomes are either long or short. In certain stages of microsporocytes one geminus composed of unequally long pair of chromosomes is seen. If the latter are sex-chromosomes, the sex of *Hydrilla* should belong to the XY-type. In root-cells we find 24 chromosomes; in some cells the number of long and short chromosomes are even, while in others they are in odd number, i.e. 15 and 9 respectively, which will suggest that the roots were taken from male plants.

**140.  On Ergosterin isolated from a Japanese edible Mushroom, *Cortinellus Shiitake.***  Mizuho SUMI. (Proc. Imp. Acad. **3**, 1928, 116–119 with figs.).

**141.  On the Fertilization of Semi-sterile Paddy Rice-plants.**  (Japanese). Iwao SUZUTA and Masaru SUEMATU. (Agric. in Formosa, No. **232**, 1927, 5 pp.).

In semi-sterile paddy rice-plants endosperm is often replaced by water, and embryoless seeds are also often found  In 16 individuals the author found 0.45–3.92, in average 1.79% of seeds of the former kind and 0–0.84, in average 0.22% of those of the latter. Abnormal seeds above mentioned may be due to the simple fertilization instead of normal double, due to the abnormal nuclear division in the embryo-sac mother-cells.

**142.  The Influence of the Higher Temperature on the Reduction Division of the Pollen Mother-cells of *Lychnis Sieboldii,* van Houtte.**  Fumi TAKAGI. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. (Biol.) **3**, 1928, 461–466, 1 pl. and 4 text-figs.).

A plant of *Lychnis Sieboldii* was kept for 3–3½ hours under the temperature of 38°–39°C. The examination of pollen mother-cells has revealed the following abnormalities. —1. The non-conjunction has occurred, and consequently 24 univalent chromosomes were found scattered in the cytoplasm. No heterotypic division having taken place dyads were produced instead of tetrads.— 2. From 24 univalent chromosomes two nuclei, large and small, with different chromosome numbers are formed.— 3. Each of 24 univalent chromosomes splits up longitudinally, thus producing about 40 chromosomes. – 4. Cell-wall formation ensues, and 1–4 cells are formed from a single pollen mother-cell.

Pollen resulting from such abnormal divisions was found to be able to germinate. Whether they have the actual fertilizing power remains undetermined.

### 143. Studien über die Stoffwechselphysiologie von *Aspergillus oryzae*. II.

Hiroshi TAMIYA. (Acta Phytochimica, 4, 1928, 77–213).

Es handelt sich in der vorliegenden Mitteilung um ein Doppeltes: der Verfasser hat sich zunächst mit der Frage nach der korrelativen Verkettung unter den physiologischen Wirkungen der verschiedenen Kationen und Wasserstoffionen beschäftigt, und dann hauptsächlich den Atmungsstoffwechsel des in Frage kommenden Pilzes von verschiedenen Seiten her studiert. Das Folgende gibt eine zusammenfassende Übersicht über die wichtigsten Resultate des vorliegenden Werkes.

1. Die Wirkung verschiedener Metalle auf das Wachstum und den Stoffwechsel von *Aspergillus oryzae* wurde bei verschiedener Acidität der Nährlösung untersucht. Während Alkalimetalle selbst bei grossem Zusatz die pH-Wachstumskurve nicht sehr modifizieren, bewirken Erdalkalimetalle bei höherer Acidität Beförderung, bei niedriger hingegen Hemmung des Wachstums. Eine ähnliche Erscheinung wurde auch bei Al, Fe, Co, Ni, Mn festgestellt, wobei aber die Wirkungsweisen der verschiedenen Metalle nicht ganz gleich sind. Die Wirkung von Zn, Cu, Hg, Ag liess sich schon bei einem geringen Zusatz zeigen, wobei in der Nähe von pH 4–5 eine Wachstumsbeschleunigung, in höherer und niedrigerer Acidität dagegen eine Wachstumshemmung mehr oder weniger deutlich auftrat.

Die Ursache solcher Erscheinungen wurden von verschiedenen Gesichtspunkten aus besprochen.

2. Bei üblicher Kulturweise (Sporenkultur) wurden, ausgenommen bei Zusatz von Cu, Hg, Ag oder Zn, fast ausnahmslos doppelgipflige pH-Wachstumskurven konstatiert, während bei fertigen Decken (Deckenkultur) diese Doppelgipfligkeit gar nicht wahrgenommen wurde, woraus folgt, dass diese eigentümliche pH-Abhängigkeit des Wachstums nur jungen Myzelien zukommt. Deckenkultur ist ausserdem gegen Alkalinität widerstandsfähiger als Sporenkultur.

3. Herabsetzung der Kojisäurebildung wurde oftmals beim mit Schwermetallen gereizten Wachstum und auch einigermassen bei Zusatz von Erdalkalimetallen beobachtet. Erhebliche Anhäufung dieser Säure wurde besonders beim Mangel der Kulturlösung konstatiert.

4. Bei $O_2$-Entziehung sind die Konidien nicht keimfähig; das Wachstum, die Konidienbildung sowie die Kojisäurebildung aufgewachsener Myzelien wird dabei auch ganz unterdrückt, statt dessen aber tritt eine auffallende Alkoholgärung, zugleich mit mehr oder minder starker Autolyse des Pilzkörpers ein.

5. Die Alkoholgärung ist um so ausgiebiger, je jünger die Myzelien sind, und je näher die Reaktion der Kulturlösung zu pH 5–6 ist. Bei dieser Acidität ist die Auto-

lyse des Pilzkörpers sehr unbedeutend und das Mengenverhältnis des gebildeten Alkohols zu $CO_2$ ungefähr 1:1, bei sonstiger Acidität fällt die Menge des $CO_2$ wegen der jeweils stattfindenden Autolyse immer grösser aus, als die des Alkohols.

6.  Alkoholbildung findet, obwohl in geringem Grad, auch bei Luftzutritt statt, wird aber durch Versenken der Pilzdecke in die Lösung ganz auffällig gesteigert.

7.  Aerobe Atmung ist auch stärker bei früherem Entwickelungsstadium.  Ihr Optimum-pH liegt bei 6–7.

8.  Eliminieren irgend einer Nährsalz-Komponente bewirkt bei aerober Kultur mehr oder minder eine Herabsetzung des Wachstums, ist dagegen für anaerobe Kultur fast ohne Belang.

9.  Durch Zusatz von $ZnSO_4$, $FeCl_2$, $CaCO_3$, Milchsäure und Oxalsäure wurde die aerobe Kultur in verschiedener Weise beeinflusst, während die anaerobe Kultur ausgenommen nur bei Zusatz von $CaCO_3$, keine wesentliche Veränderung erlitt.  Die beobachtete Herabsetzung der anaeroben Atmung bei $CaCO_3$-Zusatz ist aber sehr wahrscheinlich auf die von diesem Salz hervorgerufene stärkere Alkalinität der Lösung zurückzuführen.

10.  Wird die eine Zeitlang anaerob gehaltene Pilzdecke nachher aerob kultiviert, so atmet und wächst sie ganz normal weiter.  Die Anaerobiose übt also keinen bemerkenswerten Einfluss auf die nachfolgende Ärobiose.

11.  Der Quotient I/N sinkt von Zeit zu Zeit, wenn aber die Zunahme des Pilzgewichtes bei der Ärobiose in Rechnung gezogen wird, so fällt dieser Wert fast unabhängig vom Alter der Pilzmyzelien konstant aus, nämlich etwa 1/6.  Das Verhältnis der Energiegewinnung durch Anaero- und Aerobiose zueinander beträgt daher etwa 1/50.

12.  Das Fehlen der C-Quelle in der Nährlösung setzt die Intensität der normalen Atmung bis zu 1/4, und die der anaeroben Atmung bis zu 1/10 herab.

13.  Dass in höherer Acidität Nitrat eine bessere N-Quelle als Ammonium darstellt, und in niedriger Acidität ein umgekehrtes Verhältnis obwaltet, wurde auch bei Deckenkultur festgestellt, wobei aber im Gegensatz zur früheren Erfahrung des Verfassers bei Sporenkultur Nitrat einen höheren Nährwert zeigte.

14.  Für die Untersuchung der Gärung aerober Pilze hat der Verfasser einen neuen Gärungssaccharometer konstruiert.  Die Versuche mit fertigen Pilzdecken wurden auch durch Anwendung zweier eigens konstruierter Kulturgefässe erleichtert.
Verf.

### 144.  Über das Cytochrom in Schimmelpilzzellen.  (Vorläufige Mitteilung). Hiroshi Tamiya.  (Acta Phytochimica, 4, 1928, 215–218).

In dieser Arbeit hat der Verfasser bei einem Schimmelpilz, *Aspergillus oryzae* einen vermutlichen Atmungskatalysator, das Cytochrom, nachgewiesen.  Die Resultate der mikrospektroskopischen Untersuchung zeigten, dass der Cytochromstreifen desto deutlicher ist, je jünger die Pilzdecke ist, und dass er sehr bald verschwindet, wenn man die cytochromreiche Decke in eine $O_2$-freie Atmosphäre bringt.  Aber eine Decke, die auf solche Weise das Cytochrom verloren hat, kann es wieder erzeugen, wenn sie nochmals aerob gemacht wird, wobei die Fähigkeit der Wiedererzeugung von Cytochrom selbst bei einer 5-tägigen Anaerobiose nicht verloren geht. Durch Behandlung der anaeroben Decken mit Schwefelammonium erhielt man Streifen von Hämochromogen in alkalischer Lösung, was auf das Vorhandensein einer dem α-Hämatin nahestehenden Substanz in der anaeroben Decke hinweist.  Durch Ex-

traktion mit Pyridin wurde eine deutliche Pyridin-Hämochromogen-Reaktion sowohl bei aeroben als auch bei anaeroben Decken festgestellt, wobei merkwürdigerweise die Reaktion bei anaeroben Decken viel deutlicher war als bei aeroben. Ärobe und anaerobe Decken zeigten ausserdem gleichfalls starke Benzidin-Eisessig-Reaktion. Der Verfasser endet schliesslich seine vorläufige Abhandlung mit der Bemerkung, dass die nähere Erklärung der Luftzufuhrabhängigkeit des in Frage kommenden Farbstoffes wohl zur Aufhellung seines Umwandlungsmechanismus in lebenden Zellen beitragen könnte.                                                                Verf.

**145. The Action of Nitrates and Ammonium Salts in Some Plants.** (Japanese with an English résumé). Shôzô TOKUDA. (Bot. Mag. Tôkyô **42**, 1928, 37–56, 8 figs.)

The results obtained in the author's experiments are as follows.

The more permeable for plasma membrane the $NH_4$-salts, the more do they check the growth of fungi (*Aspergillus niger*), and the lower becomes the acidity of the culture solution. In the case of nitrates, the more permeable, the more do they check the growth of fungi, and the higher becomes the acidity of the culture solution. Salts that check the growth of fungi stimulate their respiration. When the duration of culture is short the lower concentration of nitrogen source is suitable for the growth of fungi, while when it is long, the higher concentration is better. The suitable concentration of nitrogen source for the growth of fungi depends upon the character of ion; hydrogen ion concentration has not so great influence on the growth of fungi as the character of ion. Oxalic acid is found in the culture solution containing a little quantity of nitrogen source and a large quantity of $KNO$, $NaNo$, and $(NH)HPO_4$.

**146. Über die vitale Oxydation der Pflanzenzellen mit den Kobaltamminkomplexsalzen.** Atsushi WATANABE. (Japan. Jour Bot. **4**, 1928, 37–70, 3 Taf u. 9 Textfig.)

**147. A New Species of Sphenopteris from the Lower Cretaceous of Japan.** Hisakatsu YABE. (Japan. Jour. Geol. & Geog. **5**, 1928, 223–224, 1 pl.).

A new species, *Sphenopteris yokoyamai* is described and figured.

**148. Investigations on the Course of Saccharification by *Aspergillus oryzae* (Ahlburg) Cohn.** Hachisuke YAMAGISHI. (Sc. Rpts. Tôhoku Imp. University 4th Ser. (Biol.) **3**, 1928, 179–204, 7 figs.).

The culture of *Aspergillus oryzae* in starch medium was made. The saccharifying activity of starch by its mycelia rises gradually with their growth, and its maximum is reached as soon as conidia are formed. The rate of fungus development is directly proportional to the amount of starch given (0.2–2%). The smaller the quantity of starch, the less the secretion of diastase, and consequently the less the amount of saccharified starch. When glucose is added to the 2% soluble starch, the saccharifying activity is retarded in proportion to the amount of glucose (1–4%).

**149. Notae ad Plantas Japoniae et Formosae. (VII).** (Japanese). Yoshimatsu YAMAMOTO. (Bot. Mag. Tôkyô **42**, 1928, 109–115, 4 figs.).

*Cycas taiwaniana* discovered by SWINHOE in 1867 and described by CARRUTHERS

in 1893 has since never been found by any one in Formosa, and consequently botanists were generally in doubt whether it is really present in Formosa. This plant has recently been rediscovered in a certain locality in Formosa which has been very rarely trodden by learned men. It is described and figured in detail in this paper.

**150. Supplementa Iconum Plantarum Formosanum IV.** Yoshimatsu YAMA-MOTO. 1928. (Publ. Dpt. Forest. Govern. Res. Inst. Taihoku Formosa, 4 pls. & 12 figs.).

This part contains the Latin description of the following Formosan plants : *Hymenolepis spicata, Cycas taiwaniana, Pericampylus formosanus, P. trinervatus* (nov. sp.), *Stephania cepharantha, S. Sasakii, S. tetrandra, Cissampelos Ochiaiana* (nov. sp.), *Schizophragma hydrangeoides* var. *Fauriei, Deutzia Bartlettii* (nov. sp.), *Bobua crenatifolia* (nov. sp.), *B. kotoensis* (nov. comb.), *B. modesta* (nov. comb.), *B. theophrasthaefolia, Comanthosphace stellipila, Ligularia nokozanensis* (nov. sp.), *L. stenocephala* var. *typica* f. *humilis*, forma *quinquebracta* (nov. f.), *Rhynchospermum formosanum* (nov. sp.). Each plant is generally accompanied by illustrations. Especially as regards *Cycas* the author gives 4 plates concerning *C. taiwainiana* and *revoluta* ; one of the plates refers to the anatomical structure of leaf-pinnules of *C. taiwaniana*. (S. No. 149).

**151. Physiological Researches on the Fertility in *Petunia violacea* IV. On the Effect of Secretion of the Stigma on Fertility, especially on the Self-incompatibility.** (Japanese with an English summary). Sadao YASUDA. (Bot. Mag. Tôkyô **42**, 1928, 96–108).

In various strains of *Petunia violacea*, self-compatible as well as self-incompatible, the following experiments were performed.

After the secretion of the stigma had been washed away, intra-self pollination was done, and its results were compared with those of the ordinary intra-self pollination. In incompatible strains the fertilizing percentage, the number of seeds, the size of unfertilized ovules and rife capsules, the size, weight and germination percentage of seeds, the length of seedlings, etc. were found to be larger in the former case than in the latter. In self-compatible strains, just the reverse was the case.

The germination of pollen was tested, firstly in the solution containing the stigma secretion of the same flower+1% grape-sugar, and secondly in that containing simply the latter. In self-incompatible strains the germination percentage was larger in the latter case than in the former, while in self-compatible strains the result was just the reverse. This shows that the secretion of stigma in self-incompatible strains inhibits the pollen germination.

After the washing of stigma it was smeared with the secretion from the stigma of another individual belonging to the same or different vegetative line, and the intra-self pollination was performed. Also the pollen germination was tested with the stigma secretion of the same flower, and that of the flower from an individual belonging to the same or different vegetative line. It was found that the results of both fertility and germination are best when the stigma secretion from the individual of the other vegetative line is used ; the secretion from the individual of the same vegetative line comes next, and that from the same flower is least effective.

**152. Physiological Researches on the Fertility in** *Petunia violacea* **V. On the Relation between the Soil Moisture and the Fertility.** (Japanese with an English summary). Sadao YASUDA. (Bot. Mag. Tôkyô **42**, 1928, 317–325, with figs.).

The observation was made on the fertility of *Petunia violacea* in relation to its cultivation under dry or wet condition. The flowers of the plants belonging to the same vegetative line cultivated under dry or wet condition were intra-self pollinated. It was found that the result is better under dry than under wet condition, e. g. fertilizing percentage 41 and 12 respectively.

The plant cultivated under either of the two alternate conditions was pollinated with pollen taken from the flower of the plant under dry condition. In the nearly self-sterile plants the result was better under dry than under wet condition, e. g. fertilizing percentage 16 and 7 respectively.

The germinating percentage of pollen was tested by cultivating it on the sugar solution containing the stigma secretion taken from the flower of the plant cultivated under either of the two conditions. In the plant which is wholly or partially self-sterile this percentage was greater in the case of dry than in that of wet condition, while in self-fertile plants the result was just the reverse.

**153. A Short Report on the Effect of Atmospheric Temperature upon the Germination of the Pollen Grains with Special Reference to the Fertilizing Percentage in** *Petunia violacea*. Sadao YASUDA and Gosanta SATOW. (Jour. Sc. Agric. Soc. No. **305**, 1928, 151–154).

Concerning some individuals of *Petunia violacea* belonging to several vegetative lines the germination of pollen grains and the fertilizing percentage of intra-self pollination were compared, especially in relation to the temperature. The optimum temperature for pollen germination lies at nearly 20°—32° C. The intra-self pollination was practised during several days of August, September and October, generally at 2 p.m., sometimes at 10 a.m. It was found that the fertilizing percentage is greatest, when the optimum temperature for pollen germination is prevailing at the time of pollination. Above and below the optimum temperature the fertilizing percentage decreases, hand in hand with the percentage of pollen germination.

**154. Studies on the Structure of Lignite, Brown Coal, and Bituminous Coal in Japan.** Miss Kono YASUI. (Jour. Fac. Sc. Imp. Univ. Tokyo. Section III (Botany), **1**, 381–468, 16 pls. and 22 figs.).

The result of the author's investigation may be summarized as follows :

1. Bituminois coal from twenty-two different seams and brown coal and lignite from seventeen different localities were investigated, three specimens of the bituminous coal being obtained from each seam, one each from the upper, middle, and lower layers of the seam.

2. Materials, after necessary treatment, were as a rule embedded in celloidin and microtome sections were made ; sometimes hand sections were used, while the grinding method was adopted in only one case.

3. Plant tissue in lignite and coal were microscopically studied with ordinary as well as with polarized light, and also certain chemical tests were applied.

4. Several kinds of cell walls — cutinized, suberized, lignified, chitinous, and parenchymatous cell walls — were investigated in all specimens of lignite, brown coal, and some bituminous coal. The cutinized cell wall and the chitinous cell wall

are the two most resistant vegetable elements, consequently they persist for a long time, while parenchymatous cell walls have often been destroyed and disappeared.

5. The lignified cell walls in the several different degrees of coalification showed different degrees of double refraction, the latter property being gradually lost as the coalification advanced. Keeping pace with this change in the cell wall, the cellulose is gradually abstracted from the wall. From this we may conclude that one of the essential processes in the early part of coalification is the abstraction of cellulose from the cell wall, in addition to other chemical changes taking place during the process.

6. Parenchymatous cells and tissue are sometimes in an admirable state of preservation, the morphological remains of nuclei and other cell elements being recognizable.

7. The bright coal, the dull coal, and the fusaine in bituminous coal correspond to lignitoid of JEFFREY, the matrix and the charred material in lignite.

8. More than six kinds of coniferous wood, two kinds of small branches of conifers, two kinds of angiospermous wood, a pine cone, an aerial stem of a moss of the *Polytrichum* type, leaves of mosses, more than three kinds of angiospermous pollen grains, one kind of gymnospermous pollen grain, more than two kinds of fern spores, a kind of diatom, a kind of alga, and several kinds of fungi were observed mostly in lignite, but some in bituminous coal.

9. Vegetable constituents in several seams in different localities were described.

10. From investigations of the vegetable materials in Japanese lignite, brown coal, and bituminous coal, the writer has come to the conclusion that the vegetable constituents are nearly of the same kind, and that the chief mass of Japanese coal is composed of coniferous wood.

11. The writer holds the view that the coal was formed of aqueous accumulations and transported products. From the excellent preservation of the morphological cell elements, together with the preservation of cellulose and other constituents of cell walls, and the absence of severe attacks of microorganisms in the main mass of coal-forming material, it is also maintained that the place where the accumulation took place was sterile against such microorganisms, so that microorganisms can not be taken for coal-forming agencies, as is maintained by some authors.        Author.

# Abstracts Nos. 155–247

(Referring to the principal papers on Botany and allied subjects which
have appeared in Japan chiefly during July-December 1928)

**155. Studies on a New Disease of** *Celosia cristata* **Caused by** *Fusarium
Celosiae* **n. sp.** Takuji ABE. (Ann. Phytopathol. Soc. Japan **2**, 1928, 51–63, 2 pls.).

The disease caused by a new fungus, *Fusarium Celosiae* attacks leaves, stems,
petioles and also inflorescences of *Celosia cristata*. The most vigorous growth occurs
between 28–32°C, and no growth was observed at 8–10°C. It dies in hot water
kept at 62°C within 10 minutes. The diagnosis of the fungus is given.

**156. The Crab-apples and Nectarines of Japan.** Yoshichi ASAMI. Tokyo
1927, 89 pp., 50 figs. (mostly photographs), and 50 pls., partly coloured.

This is a monograph of Japanese crab-apples and nectarines.

I. CRAB-APPLES.—All species of the genus *Malus* found in Japan, either wild
or cultivated (except European apples) are enumerated, viz. *M. asiatica* NAKAI,
*M. prunifolia* BORKHAUSEN, *M. micromalus* MAKINO, *M. Halliana* KOEHNE, *M.
baccata* BORKHAUSEN, and *M. cerasifera* SPACH; each species contains a number
of new varieties and forma created by the author. All species, varieties, and
forma are fully described with illustrations; besides, their use, history of cultiva-
tion, etc. are appended.

Certain observations concerning the number of styles in *Malus* are noted. A
short chapter on the relation of leaf-vernation and the heterophyllous character
follows.

II. NECTARINES.—*Prunus persica* var. *nucipersica* DIPPEL and all its varieties
found in Japan are described in full. An account is given of a remarkable tree
in the garden of the Iwate Hospital, which bears both nectarines and peaches on
one and the same branch, and also fruits belonging partly to the one and partly
to the other in the manner of sectorial chimera. The chapters on the history of
Japanese Nectarines and their value as fruit-trees terminate the part concerning
the nectarines.

The literature cited, the explanation of plates, and the index close the text of
the book.

**157. Ueber eine neue schwefeloxydierende Bakterie.** (Mit japanischer
Zfg). Yoshikadzu EMOTO. (Bot. Mag. Tôkyô **42**, 1928, 421–426, 2 Abb.).

Aus dem sauer reagierenden Gemisch von Thermenwasser und dessen schlei-
migem schwefelhaltigem Absatz von Yumoto Schwefelthermen wurde eine Bakterie
isoliert, *Thiobacillus thermitans* n. sp., welche *T. thiooxidans* WAKSMAN, JOFFE
und STARKEY ähnlich ist und doch daraus durch ihre Grösse $(2,0 \times 0,5 \mu)$, ihre Be-
weglichkeit mit einer monotrichen Geissel und ihre negative Reaktion GRAMS unter-
scheidet. *Thiobacillus thermitans* ist ein autotropher Organismus, dessen Energie-

quelle durch Oxydation von elementarem Schwefel oder Thiosulfaten zu Schwefelsäure zugedeckt wird. Die Reinkulturen wurden ausgeführt. Die Bakterie wächst weder auf gewöhnlichem Agar- und Gelatineboden noch in Bouillon und Milch, sondern in besonderen Nährmedien aus anorganischen Verbindungen.

**158. On the Myxomycetes newly Found in Japan.** (Japanese with English résumé). Yoshikadzu EMOTO. (Bot. Mag. Tôkyô **42**, 1928, 536–543, 2 pls.).

The following seven Myxomycetes are new to Japanese Flora: *Arcyria globosa, Badhamia nitens, Cienkowskia reticulata, Didymium crustaceum, Leocarpus fragilis, Physarum bogoriense*, and *P. serpula*.

**159. A New Palaeozoic Species of *Sequoia*.** Seidô ENDÔ. (Japan. Jour. Geol. & Geogr. **6**, 1928, 27–29, 1 pl.).

*Sequoia chinensis* n. sp. from Manchuria and Japanese Saghalin is described and illustrated.

**160. Studies on *Hypochnus centrifugus* from *Trifolium repens*.** (Japanese.) Shigeru ENDÔ. (Jour. Microbiol. & Pathol. Japan **22**, 1928, 1851–1866, with 2 figs.).

*Hypochnus centrifugus* (LÉV.) TUL. which is found parasitic on *Trifolium repens* was isolated, and its pathogenicity towards various other plants was studied. It is able to infect the leaf-sheaths and ligules of rice-plants, whether wounded or not, though its pathogenicity is feeble. It can infect also tobacco, cucumber, white clover, and watermelon, whether wounded or not. Under 20°C no infection will take place. At 65–66° its sclerotia die after about 4 hrs., at 90–91° after about 40 min., and at 91–96° after about 30 min. The death by high temperature takes place much more quickly under moist than under dry condition.

**161. Genetic Studies of Leaf-characters in Japanese Morning Glories VIII. On Some Observations of the Seedlings.** (Japanese with English résumé). Tokio HAGIWARA. (Bot. Mag. Tôkyô **42**, 1928, 349–365, 3 figs.)

The writer distinguishes in Morning Glory two classes of albinos, viz. those lacking chlorophyll and those lacking anthocyanin. In the latter class some are totally devoid of anthocyanin, while others possess them partially in stems, flower-tubes and seeds. Anthocyanin albino is a Mendelian recessive to anthocyanin plant. Anthocyanin in corolla may be due at least to three pairs of genes ($C^a$, $c^a$, **C, c, R, r**). Seedlings are green, white (which soon perish), or yellow. White is recessive to either green or yellow. The author thinks that the appearance of this albino may be due to the co-existence of the three recessive factors (**g, g′, g″**):

Several kinds of abnormal cotyledons were found in the hybrids, such as tricotyly, syncotyly, amphi-syncotyly, giant cotyly. The author considers the appearance of such abnormalities being due to genotypic causes. Tricotyledonous plants do not breed true, but segregate out about 85% normal strains.

**162. Genetic Studies of Flower-colours in Japanese Morning-Glories II. On the Complementary Factors concerning the Shade of Flower-colours.** (Japanese with English résumé). Tokio HAGIWARA. (Bot. Mag. Tôkyô **42**, 1928, 395–408, 1 fig.).

The dull or broken colour is hypostatic to any pure colour. The production of the latter is due to the co-existence of two complementary factors $K_1$ and $K_2$, while the broken colour should be due to that of one or both factors $k_1$ and $k_2$. The strains with broken colours do not breed true, and produce besides themselves 7-8 % pure-coloured plants, and it may be supposed that the transformations $k_1 \to K_1$ and $k_2 \to K_2$ take place.

A dull-coloured flower bearing a few blue spots was found among the offspring ex blue × dull-coloured. Among the offspring of the blue-coloured segregated out in $F_2$ one dull-coloured individual was found, which has produced the blue-flowered bud variate. Also some dull-coloured offspring in $F_2$ have segregated out besides those similar to themselves some blue ones. The author supposes that a recessive factor, though unable to produce blue colour on dull colour-ground, has the tendency to accelerate its allelomorphic transformation to dominant state.

### 163. On the Systematic Importance of the Stelar System in the Filicales III. (Japanese). Bunzô HAYATA. (Bot. Mag. Tôkyô 42, 1928, 334–348, 8 figs.).

In this continuation of the author's anatomico-systematic studies of the Filicales the following species are treated of: *Amesium Sasakii* HAYATA n. sp. (with Latin diagnosis), *Boninella Ikenoi* HAY. (with Latin diagnosis of the genus *Boninella*), *Brainea formosana* HAY., *Micropolypodium pseudotrichomanoides* HAY. (with Latin diagnosis of the genus *Micropolypodium*), *Monomelangium Hancockii* HAY., *Pentarhizidium japonicum* HAY. sp. nov. (with Latin diagnosis), and *Protangiopteris Somai* HAY.

### 164. An Outline of the Investigation on the Seed- and Seedling-rot of Rice Caused by a Water-mould, *Achlya prolifera* Nees. Takewo HEMMI and Takuji ABE. (Japan. Jour. Bot. 4, 1928, 113–123, 1 pl.).

### 165. On a Staining Method for testing the Viability of Sclerotia of Fungi. Takewo HEMMI and Shigeru ENDÔ. (Mem. Coll. Agric. Kyoto Imp. Univ. No. 7, 1928, Art. 3, 39–49, 1 pl.).

Eosin and fuchsin, etc. are advantageously usable for distinguishing between living and dead sclerotia, for the sections of the latter are stained much more deeply than those of the former. The method is as follows: stain two minutes by a 1 % aqueous solution of eosin, then wash 1-2 minutes with water, or stain 2 minutes by 1-2 % aqueous solution of acid fuchsin and then wash ½ –1 minute with water.

### 166. Studies on *Polyporus orientalis* parasitic on the Roots of Pine-trees. (Japanese with English résumé). Takewo HEMMI and Tomowo NOJIMA. (Ann. Phytopathol. Soc. Japan 2, 1928, 70–88, 2 pls.).

*Polyporus orientalis* which is widely distributed throughout Japan is found in the vicinity of Kyoto as parasitic on roots of *Pinus densiflora*. Pure culture of this fungus is easily to be done. The author has compared the growth habit of the mycelium in sixteen different nutrient media, and found agar and apricot decoction to be most favorable as nutrient media. The relation of the temperature to the growth of the fungus was studied, and it was found that the optimum

temperature lies between 28° and 32°C; the maximum and minimum are about 38°C and 12°C respectively.

The morphological characters of the fungus are described in detail. Also the reactions of the yellow pigment contained in the sporophores towards various chemicals were studied.

**167. Experimental Studies on the Pathogenicity of Certain Fungi on Rice Seedlings.** Takewo HEMMI and Kuniomi YOKOGI. (Mem. Coll. Agric., Kyoto Imp. Univ. No. **7**, 1928, Art. 1–22, 2 pls. and 1 fig.).

The authors have studied by means of artificial inoculation that there are various fungi which may cause the root and foot rot of the rice seedlings, for instance, *Piricularia Oryzae, Helminthosporium Oryzae, Hypochnus Sasakii, H. centrifugus, Sclerotium oryzae sativae.* As to the fact, whether his experimental results are directly applicable to natural phenomena the authors did not make any definite conclusion, but they think that at any rate the rice seedlings have the tendency to be attacked, if they are planted in the nursery-bed favorable for the fungus growth.

**168. The Bacterial Leaf-spot of Sugar-beet.** (Japanese with English résumé). Eikiti HIRATA. (Jour. Agric. Exp. Sta., Gov.-Gen. Korea No. **17**, 1928, 33 pp., 4 pls.).

A leaf-spot disease of sugar-beet which causes serious damage in some parts of Korea is due to a microorganism which the author thinks to belong to a strain of *Bacterium aptatum.* Its morphological characters are described in detail. The pure culture was made, and its physiological as well as its behaviour towards various temperatures were investigated. Inoculation experiments have proven that it can infect not only sugar-beet, but also various other plants. It survives in diseased seeds or beet tops left over in the field, which is the primary source of the infection. The methods of control are discussed.

**169. Additional Notes on the Melampsoraceae of Hokkaidô.** Naohide HIRATSUKA. (Bot. Mag. Tôkyô **42**, 1928, 503–504).

This paper is a supplement to the list of the Melampsoraceae in Hokkaidô published in Japan. Jour. Bot. 3, 1927, 289–322. Three species are mentioned, of which one, *Phakospora Itôana* HIRATSUKA et TANAKA is a new species and described. Some new hosts on 4 species already published are also mentioned.

**170. Notes on the Melampsoraceae Collected in the Kuriles.** (Studies on the Melampsoraceae of Japan VIII). (Japanese). Naohide HIRATSUKA. (Jour. Soc. Agric. & Forest, Sapporo **19**, 1928, 564–568).

11 species are mentioned, which belong to *Melampsorella* (1 sp.), *Pucciniastrum* (2 sps.), *Thekopsora* (3 sps.), *Hyalospora* (1 sp.), *Chrysomyxa* (2 sps.), *Peridermium* (1 sp.), and *Caeoma* (1 sp.).

**171. On the Powdery Mildew of Flax.** Yasu HOMMA. (Bot. Mag. Tôkyô **42**, 1928, 331–334, 2 figs.).

Two species of *Erysiphe* were found as parasitic on flax. The one is *E. Polygoni* DC. which has produced both conidia and perithecia. The other is probably *Oidium lini* Škoviċ with conidia; no perithecia were found in the latter. A description is given in respect to either of the two species.

Entries 167–171

**172. Nuntia ad Floram Japoniae.** (With Japanese résumé). Masaji HONDA. (Bot. Mag. Tôkyô **42**, 1928, 506–509, 544).

Five new plants are described: *Carex conicoides, Eriocaulon senile, Gentiana scabra* var. *Buergeri* subvar. nov. *saxatilis, Eragrostis aquatica, Mesisteria nudipes.*

**173. On the Development of Swarmspores of *Heterochordaria abietina.*** (Japanese.) Jiro IKARI. (Bot. Mag. Tôkyô **42**, 1928, 412–419, 4 figs.).

The account of the author concerns *Heterochordaria abietina* (RUPR.) S. et G., formerly called *Chordaria abietina* RUPR. and now placed among a new family Heterochordariaceae. After a short description of its anatomical and morphological characters the author describes the results of his culture experiment of the swarmspores of this alga. The swarmspores liberated from the unilocular sporangium come to rest, and then become the embryospores. The latter begin to germinate after a few days, and from them the sporelings are developed, which are at first filamentous and then become disc-shaped. No sexual organs were observed on these plantules. In nature the author has often met with the sporelings. Whether they are derived from the swarmspores or sexual zygotes remains undetermined. The author thinks it to be very probable that there are the gametophytic and the sporophytic plantules which differ neither in shape nor in size.

**174. Fungous Diseases of the Insect-powder Plant.** (Japanese with English résumé). Suehiko IKATA. (Ann. Phytopathol. Soc. Japan **2**, 1928, 140–158, 2 pls.).

In the insect-powder plant (*Chrysanthemum cinerariifolium*) the author has found the six kinds of diseases: 1. the blight caused by *Diplodia chrysanthemella* n. sp., 2. the small sclerotium disease by *Sclerotium minor*, 3. the large sclerotium disease by *Scl. Libertiana*, 4. the sclerotium wilt by *Scl. Rolfsii* (=*Hypochnus centrifugus*), 5. the fusarium wilt by *Fusarium* sp. and 6. the septoriose by *Septoria chrysanthemella*. Among these diseases Nos. 1, 2 and 3 are most prevalent. Inoculation experiments were performed in all cases except in No. 6.

**175. Ueber einen Fall des Dominanzwechsels bei einem Bastard von *Capsicum annuum*.** Seiitirô IKENO. (Proc. Imp. Acad. **4**, 400–403, 1 Abb.).

Der Verf. fand vor 15 Jahren bei dem Bastarde zwischen den Sippen von *Capsicum annuum* mit hängenden bzw. aufrechten Blütenstielen, einen eigentümlichen Dominanzwechsel, insoferne als der Blütenstiel von $F_1$-Pflanzen aufrecht steht (aufrecht dominant über hängend!) und er allmählich zu dem hängenden Fruchtstiel auswächst (hängend dominant über aufrecht!) Der soeben genannte Dominanzwechsel findet im Sommer statt. Nun fand der Verf. dabei weiter einen anderen Dominanzwechsel. Im Herbst dominiert nämlich die hängende Stellung des Blütenstieles von vornherein über die aufrechte. Vom Sommer nach dem Herbste hin nimmt somit die Zahl der hängenden Blütenstiele allmählich zu, um schliesslich im Anfang Winters fast keine aufrechte Blütenstiele mehr nachweisbar zu sein (Dominanz der aufrechten Stellung des Blütenstieles über die hängende im Sommer und die umgekehrte im Herbst). Verf.

Entries 172–175

**176. Studien über die Vererbung der Blütenfarbe bei *Portulaca grandi-flora*. III. Mitteilung. Mosaikfarbe.** Seiitirô IKENO. (Japan. Jour. Bot. 4, 1928, 189–217, 1 Taf.).

**177. Ueber *Cladopus japonicus* n. sp., eine Podostemonacee in Japan.** Shun-ichiro IMAMURA. (Bot. Mag. Tôkyô 42, 1928, 379–387, 2 Taf.).

Eine neuerdings vom Verf. in Südjapan entdeckte Podostemonacee, *Cladopus japonicus* nähert sich in vielen Beziehungen der javanischen Art, *C. Nymani* Hj. MÖLLER. Die Unterscheidungsmerkmale zwischen beiden sind wie folgt. Erstens: die Seitenzweige bzw. -Wurzeln bei *C. japonicus* sind gewöhnlich alternierend im Gegensatz zu *C. Nymani*, wo sie gegenständig stehen. Zweitens: jedes handförmiges Blatt ist mit 8–12 Lappen versehen; ein im Mesophyll laufendes Leitbündel verzweigt sich und endet in diesen Lappen bei *C. japonicus*, während bei *C. Nymani* es 2–3 reduzierte Gefässbündel gibt, welche die Lappen nicht erreichen. Drittens: die Narbe ist schmal fächerförmig in *C. japonicus*, während in *C. Nymani* sie zugeplattet dreieckig lanzettlich ist. Viertens: in *C. japonicus* befindet sich ein Leitbündel in der Mitte der Plazenta, welches in *C. Nymani* überhaupt fehlt. Fünftens: bei *C. japonicus* gibt es keine Differenzierung zwischen assimilierenden und floralen Wurzeln, während sie bei *C. Nymani* deutlich differenziert sind.

**178. On the Spiral Structure of Chromosomes in *Hosta Sieboldiana* Engl.** (Japanese, explanation of photographs in English). S. INARIYAMA. (Bot. Mag. Tôkyô 42, 1928, 486–489, with photomicrographs).

In the pollen mother-cells of *Hosta Sieboldiana* treated with acetic carmine the author could observe the scarcely stained ground substance of chromosomes with well stained spiral structure. The haploid number of chromosomes is 24. The spiral structure can be observed in both large and small chromosomes. In the metaphase and anaphase of the heterotypic division the spiral structure is especially well observable.

**179. On the Anthocyanin Pigments of Morning Glory, II.** Takeo KATAOKA. (Proc. Imp. Acad. 4, 1928, 389–392).

**180. On the Affinity of Rice Varieties as Shown by the Fertility of Hybrid Plants.** (Japanese with English résumé). Shigemoto KATO, Hirosi KOSAKA, and Shiroku HARA. (Bult. Sc. Fak. Terk., Kjuŝu Imp. Univ. 3, 1928, 132–147).

According to the authors' view the cultivated varieties of rice may be distinguished into two types, *japonica* and *indica*. The former is found in Japan proper, Korea and North China, while the latter occurs in South China, India, Java, etc.

Both varieties as well as the hybrids within one and the same type are highly self-fertile, but the hybrids between different types are much less fertile. The pollen formation goes quite normal in the former case, but abnormal in the latter, producing a large percentage of imperfect grains. In $F_2$ generation the same behaviour is observed.

**181. Ueber die chemischen Bestandteile der Frucht von *Ginkgo biloba*.** (I. Mitteilung). Jippei KAWAMURA. (Japan. Jour. Chem. 3., 1928, 89–108).

**182. Contributiones ad Salicologiam japonicam III.** Arika KIMURA. (Bot. Mag. Tôkyô **42**, 1928, 566–576, 2 Abb.).

Die folgenden *Salix*arten usw. sind ausführlich lateinisch beschrieben: *Salix algista* SCHNEIDER, *S. Bakko* sp. nov., *S. gracilistyla* MIQUEL var. *pendula* var. nov., *S. gracilistyloides* KIMURA, *S. Hayatana* sp. nov., *S. japonica* THUNBERG var. *angustifolia* var. nov., *S. Nakamurana* KOIDZUMI var. *yezoalpina* comb. nov., *S. pauciflora* KOIDZUMI var. *stenophylla* var. nov.

**183. Preliminary Report on the Luminous Symbiosis in *Sepiola birostrata* Sasakii.** Teijiro KISHITANI. (Proc. Imp. Acad. **4**, 1928, 393–396, 5 figs.).

In the luminous sac composing the luminous organ of *Sepiola birostrata*, a Squid living in the coasts of Central and Northern Japan a mass of bacteria emitting a beautiful green light is found living. Their pure culture was made. Their morphology and physiology were studied. The organism is a new species *Micrococcus Sepiola*, closely resembling *Coccobacillus Pierantonii*. The diagnosis is given.

**184. L'Étude de l'Organe photogène du *Loligo edulis* Hoyle.** Teijiro KISHITANI. (Proc. Imp. Acad. **4**, 1928, 609–612, 3 figs.).

Les organes photogènes du *Loligo edulis* HOYLE se composent de trois parties, dont la partie lumineuse est un corps rond pourvu d'un tissu glandulaire. Il est composé des tubules sécréteurs, où se trouve une certaine quantité de bactéries lumineuses. L'auteur qui les a isolées en a fait la culture sur quelques milieux nutritifs et étudié leurs propriétés physiologiques. La bactérie en question resemble beaucoup le *Coccobacillus Pieranthonii* MEISENER, mais elle en diffère par pouvoir attaquer la mannite et aussi par l'absence des cristaux autour de ses colonies. L'auteur la considère comme une nouvelle espèce *C. Loligo*.

**185. Ueber den Effekt der Anwendung der "Pulvermethode" für die Bestimmung des Stoffgehaltes im Pflanzenkörper. IV. Vergleichende Bestimmung des Aschengehaltes an den physiologisch und oekologisch verschiedenen Pflanzenkörpern.** (Japanisch mit deutsch. Zfg.). Riichiro KÔKETSU und Makoto TAKENOUCHI. (Bult. Sc. Fak. Terk., Kjûsu Imp. Univ. **3**, 1928, 154–181).

Der Aschengehalt des Pflanzenkörpers, und zwar hauptsächlich des Blattes unter verschiedenen Lebensbedingungen wurde vergleichend bestimmt. Die Trockengewichts-, die Frischgewichts- und die "Pulvermethode" KÔKETSUs wurden dabei parallel angewandt. Die Brauchbarkeit und Vorzüglichkeit der letzten Methode bei diesen Experimenten sind von den Verfn. erkannt und angedeutet.

**186. Ueber den Unterschied zwischen den Röntgengeschwülsten und den Nebenwurzeln, die in den aus bestrahlten *Vicia faba*-Samen hervorgegangen sind.** Hideo KOMURO. (Proc. Imp. Acad. **4**, 1928, 404–407, 4 Abb.).

PERAREK hat die Vermutung geäussert, dass die RÖNTGENgeschwüste KOMUROS nichts anderes seien als die Anlagen einer Nebenwurzel. Früher hat der Verf. gegen diese Meinung ausgesprochen (vgl. Japan. Jour. Bot. **4**, (40), Nr. 112). In der vorliegenden Mitteilung hat der Verf. durch den Vergleich der von ihm auf-

gefundenen RöNTGENgeschwülsten und Nebenwurzelanlagen den Unterschied zwischen beiden gezeigt, um seine Ansicht zu bestätigen.

**187. Kann man den sog. "Radkern" der Plasmazellen genetisch als ein Gebilde sui generis betrachten?** Hideo KOMURO. (Proc. Imp. Acad. 4, 1928, 500–502, mit Abb.).

Der "Radkern" der Plasma- oder Mastzellen wird im allgemeinen genetisch als ein Gebilde sui generis aufgefasst. Der Verf. hat an den durch RöNTGENstrahlen oder Kohlenteer behandelten Materialien vielfach die "Radkerne" beobachten können, welche aus hyperchromatischen Kernen durch den Zustand der Kernvakuolisierung abgeleitet werden können. Der Verf. äussert seine Ansicht dahin, dass der sog. "Radkern" nichts anderes ist als eine Stufe der Kerndegeneration.

**188. Studies on Overwintering, Primary Infection and Control of Rice Blast Fungus, *Piricularia Oryzae*.** (Japanese with English résumé). Kazue KURIBAYASHI. (Ann. Phytopathol. Soc. Japan **2**, 1928, 99–117).

According to the author's experiments the conidia on diseased straw and seed, when kept in dry condition at room temperature, may live more than one year, while the mycelia kept under the same condition may retain their vitality much longer than the conidia. Both conidia and mycelia will die much sooner under moist condition. The mycelia which have overwintered produce conidia on the surface of the substrata when moist, and most luxuriously at 18-30°C. Such conidia may infect healthy plants, so that either the conidia on any part of rice plants which suffer from the disease or the mycelia within the tissue of diseased spots are the principal organs for the overwintering of the fungus. (Cf. SUEDA, (73), No 225.—Ed.)).

**189. On the Symptoms and Causal Fungus of the "Bakanae"-disease of Rice-plants.** (Japanese). Eiiti KUROSAWA. (Rpt. Nat. Hist. Soc. Formosa **18**, 1928, 230–247, 1 pl.).

The "Bakanae"-disease of rice-plants affects the plants themselves and their seeds. The diseased culms are longer, more slender and less green than the healthy ones, and die generally after a certain time, though few may live so long as to produce few whitish panicles.

The causal fungus is considered by the author to be *Lisea Fujikuroi* SAWADA. The conidial generation of the causal fungus of this disease is generally referred to *Fusarium heterosporum* NEES, but whether the latter and *Lisea Fujikuroi* stand in close genetical relation to each other, is not yet clear.

**190. The Relative Sexuality in *Synchytrium*.** Shunsuke KUSANO. (Proc. Imp. Acad. **4**, 1928, 497–499).

All planogametes of *Synchytrium fulgens* SCHRÖT. exhibit no morphological differences among them. One of the gametes which is at first pear-shaped and active becomes afterwards spherical and sedentary, while the other which is still active comes to copulation with the sedentary one. The zygote is thus formed. The gametes from one gametangium may copulate to each other, so that the haplomonoecism is indicated. All gametes are at first active and may act as males,

while all which become sedentary are females. In the author's own words,"....it may happen that to a sedentary gamete combines an active one, upon which the sedentary stage is approaching. In this case, the latter gamete, while attempting to fuse, turns into a female....The result manifests what is called the relative sexuality."

**191. On the Sclerotial Disease accompanying the So-called Winter Injury of Barley.** (Japanese). Takashi MATSUMOTO. (Jour. Plant Prot. **15**, 1928, 6 pp.).

A certain sclerotial fungus was found on the winter barley, wheat and rye which were affected by the so-called winter injury. The occurrence of the injury is noticed almost every year, chiefly in the northern parts of Japan, and occasionally proves to be very destructive to those plants. The author considered this fungus might be identical with *Typhula graminum* KARST. reported by ERIKSSON from Scandinavia and subsequently by some other investigators from the northern parts of Europe, nevertheless he could not definitely confirm it, because he was unable to get any knowledge of its spores. Recently the author had the opportunity to examine many exsiccates of *Typhula graminum* during his stay in Europe, although he was unable to find any spores on those specimens, and confirmed his fungus to be identical with *Typhula graminum* (Fungi paras. Scandinav. Exsiccati Fasc. **1**. Nr. 30) or with *Sclerotium fulvum* FR. (DE THÜMEN: Mycotheca universalis No. 1899). The culture of the fungus is only secured when it is kept in a refrigerator. It can hardly grow when the temperature rises up to 15°C, but continues its growth at 0°C or even below zero. The sclerotia are spherical or elliptical (0.7-2 mm); reddish brown with waxy lustre. The sclerotia produce white filaments, when the cultures kept in a refrigerator for several months, but up to this time no spore formation was found on any of these filaments. The author proposed to keep the name of *Sclerotium fulvum* FR. until the better knowledge of its spores is available.                                                         Author.

**192. Beobachtungen über die Sporenbildung des Pilzes, *Cercosporina Kikuchii.*** (Mit japanischer Zfg.) Takashi MATSUMOTO. (Ann. Phytopathol. Soc. Japan **2**, 1928, 65-69 mit Textabb.).

Vormals hatte der Verf. in seinen Studien über die durch *Cercosporina Kikuchii* veranlassten Purpurfleckenkrankheit der Sojabohnen auf die grosse Schwierigkeit der Beobachtung reichlicher Konidienbildung bei diesem Pilze hingewiesen. Der Verf. veröffentlicht diesmals einige Fälle seiner Beobachtung hinsichtlich dieser Tatsache. Z.B. hat er an den in PETRISchale unter Zimmertemperatur 18-23°C (Tag) und 5-18°C (Nacht) gelegten kranken Bohnen die Bildung der Konidien beobachten können. Die letzteren können unter verhältnismässig hoher Temperatur und Feuchtigkeit sofort nach ihrer Bildung keimen. Die Konidienbildung wurde auch an der inneren Fläche der erkrankten Hülsen, an den purpurbraunen kranken Flecken der Blätter, Stämme und Kotyledonen, auch an dem Myzel auf 10 % Traubenzucker erhaltenden Kartoffelagar usw.

**193. On a New Leaf-spot Disease of *Impatiens Balsamina* L. Caused by *Cercospora Fukushiana* n. sp.** (With Japanese résumé). Isamu MATSUURA. (Trans. Tottori Soc. Agric. Sc. **1**, 1928, 83-88. 2 figs.).

A leaf-spot disease of *Impatiens Balsamina* which is noticed at several localities of Southern Japan, is due to a fungus *Cercospora Fukushiana* n. sp. The

diseased leaves are characterized by the production of pale brown, grayish or whitish spots, which are circular, oval or rectangular in outline and 1–7 mm in diameter. These spots, though whitish or grayish white in the center, are reddish brown or brown in their margin, and distinctly marked from the healthy portions.

The causal fungus was isolated and cultivated in various nutrient media; it was found that it produces abundantly colourless conidia on apricot decoction agar, though on any other nutrient medium used by the author no conidia were produced. Inoculation experiments have given positive results.

**194. Ueber die Regenerationsfähigkeit der Blätter von *Pinellia ternata* Breitend.** (Japanisch mit deutsch. Zfg.). Shigeru MIKI. (Sep. aus der Festschriftensammlung bei dem 25ten Jubiläum der land- und forstw. Hochschule zu Morioka 1928, 8 S. und 1 Taf.).

Die Stecklinge von *Pinellia ternata*, sowohl aus den ganzen Blättern und deren Teilen, wie Blattstielen, Blattscheiden als aus den Inflorescenzständen, besitzen eine starke Tendenz, Bulbillen zu erzeugen, ohne jedoch Wurzeln auszubilden. Der Ursprung der Bulbillen ist endogen. Die Knospenbildung tritt meistens am basalen Teile des Stecklings auf, wenn mehr oder weniger variabel nach den Umständen.

**195. Einfluss der niederen Temperatur auf die Lebensdauer der Kirschblüten.** Manabu MIYOSHI. (Proc. Imp. Acad. 4, 1928, 541–542).

Die Zweige von verschiedenen *Prunus*arten wurden mit ihren Schnittenden im Wasser gelegt und im Eisschrank gebracht, wobei die Temperatur 5–7°C oder etwas höher beträgt. Dabei wurde die Tatsache beobachtet, dass die Blüten der Versuchsobjekte bedeutend länger intakt bleiben als bei den Kontrollen.

**196. Untersuchungen über japanische Kirschen III.** Manabu MIYOSHI. (Bot. Mag. Tôkyô **42**, 1928, 545–552).

Die folgenden japanischen Kirschen sind ausführlich beschrieben: *Prunus floridula* n. sp., *P. mutabilis* MIYOS. f. *hirtella* n. f., *P. serrulata* LINDL. f. *gosho-odora* n. f., f. *megalantha* n. f., f. *appendiculata* n. f., f. *robusta* n. f., f. *brevistelis* n. f., f. *polycarpa* n. f., f. *sphaerantha* n. f., f. *subhirtella* J. D. HOOK. f. *semperflorens* n. f., subf. *plena* n. subf., *P. parviflora* (MATSUM.) KOEHNE.

**197. *Torreya igaensis*, a New Species of the Genus *Torreya*, and *Torreya macrosperma*.** (Japanese with English résumé). Kin-ichi MORIKAWA. (Bot. Mag. Tôkyô **42**, 1928, 533–536, 4 figs.).

*Torreya igaensis* DOI et MORIKAWA nov. sp. is distinguished from other species of *Torreya* by the smallness of its seeds as well as the short leaves with obtuse or mucronate apex. It is fully described. Small twigs, leaves and their cross-sections, as well as fruits of *T. macrosperma*, *nucifera* and *igaensis* are figured and compared.

**198. Preliminary Note on Interspecific Hybridization in *Brassica*.** Toshitaro MORINAGA. (Proc. Imp. Acad. 4, 1928, 620–622 with figs.).

Many species of *Brassica* were studied by the author for determining the number of chromosomes. It was found that it is generally 10 or 18 (haploid), as already observed by the former investigators, but in *Brassica Napella* he found the number 19, which is new for the genus.

Several crosses have been made. In those between different 10-chromosomic species the hybrids are intermediate between the two parents, and the reduction division is quite normal. In the crosses between the plants with 10 and 18 chromosomes the hybrids resemble the latter and were sterile. In the reduction division, though the bivalents arrange themselves in the equatorial plane, the univalents are mostly scattered irregularly and distributed to two poles by chance. Univalents are split in normal way in the homoetypic division.

In the crosses between the 10- and 19-chromosomic plants the hybrids are somewhat fertile and resemble more the latter than the former. The reduction division is similar to those in the hybrids between the 10- and 18-chromosomic plants.

The hybrids between the 18- and 19-chromosomic plants and also the $F_1$ hybrids between *Raphanus* and *Brassica* are sterile. (Cf. TERASAWA und SHIMOTOMAI, (75), No. 234.—Ed.).
Author.

### 199. On the Chromosome Number of *Pharbitis Nil*, Chois. (Japanese).

Masato NAGAO. (Bot. Mag. Tôkyô 42, 501, 2 figs.).

The chromosome number in the root-tip cell of a strain of *Pharbitis Nil* was counted and found to be 30. (Cf. YASUI, this No., (78), No. 245.—Ed.).

### 200. Notulæ ad Plantas Japoniæ & Koreæ XXXVI. Takenoshin NAKAI,

(Bot. Mag. Tôkyô 42, 1928, 451-479).

This paper gives an account of new species and varieties of Japanese and Korean plants, and also that of some remarkable plants of which the writer had made comparative studies during his sojourn in Europe and America from 1923 to 1925.

I. New species and varieties :—

1. *Saxifraga madida* MAKINO var. *variegata* NAKAI—Japan
2. *Sambucus Sieboldiana* BLUME var. *aurantiaca* NAKAI—Japan
3. *Deutzia Sieboldii* KOERNICKE var. *aurescens* NAKAI—Japan
4. *Euonymus japonicus* THUNBERG var. *longifolius* NAKAI—Japan
5. *Abies sikokiana* NAKAI—Japan
6. *Arisæma Maximowiczii* NAKAI—Japan
7. *Arisæma Thunbergii* BLUME var. *pictum* NAKAI—Japan
8. *Ranunculus aquatilis* LINNÆUS var. *japonicus* NAKAI—Japan
9. *Lespedeza satsumensis* NAKAI—Japan
10. *Lespedeza Uekii* NAKAI—Korea
11. *Chrysanthemum japonense* NAKAI—Japan
12. *Chrysanthemum pacificum* NAKAI—Japan
13. *Chrysanthemnm Makinoi* MATSUMURA & NAKAI var. *laciniatum* NAKAI—Japan
14. *Chrysanthemum Makinoi* var. *elatum* NAKAI—Japan
15. *Spiræa Ogawai* NAKAI—Japan
16. *Spiræa pubescens* TURCZANINOW var. *lasiocarpa* NAKAI -Korea
17.     ,,     ,,     var. *leiocarpa* NAKAI—Korea
18. *Spiræa tsusimensis* NAKAI—Japan
19. *Spiræa chartacea* NAKAI—Korea

20. *Spiræa ulmifolia* SCOPOLI var. *pilosa* NAKAI—Korea
21. *Exochorda serratifolia* S. MOORE var. *oligantha* NAKAI—Korea
22. *Solidago hachijoensis* NAKAI—Japan
23. *Atractylis koreana* NAKAI—Korea
24. *Eriocaulon sachalinense* MIYABE & NAKAI—Saghalin.

II. New combinations and new names:—
1. *Arisæma sikokianum* var. *integrifolium* NAKAI, comb. nov.
2. *Chrysanthemum indicum* f. *Decaisneanum* NAKAI, comb. nov.
3.     „          „       var. *leucanthum* NAKAI, comb. nov.
4. *Chrysanthemum ornatum* f. *incompletum* NAKAI, comb. nov.
5.     „          „       f. *modestum* NAKAI, comb. nov.
6.     „          „       f. *hortense* NAKAI, comb. nov.
7.     „          „       f. *discoideum* NAKAI, comb. nov.
8.     „          „       var. *Miquelii* NAKAI, nom. nov.
9.     „       *Makinoi* var. *japonicum* NAKAI, comb. nov.
10. *Spiræa media* var. *monbetsusensis* CARDOT, comb. nov.
11. *Phaseolus Ricchardianus* var. *typica* NAKAI, comb. nov.
12.     „          „       var. *pallida* NAKAI, nom. nov.
13. *Perilla acuta* NAKAI, comb. nov.
14.     „     „    f. *viridis* NAKAI, comb. nov.
15.     „     „    f. *purpurea* NAKAI, comb. nov.
16.     „     „    f. *discolor* NAKAI, comb. nov.
17. *Perilla crispa* f. *viridi-crispa* NAKAI, comb. nov.
18.     „     „    f. *rosea* NAKAI, comb. nov.
19.     „     „    f. *atro-purpurea* NAKAI, comb. nov.
20. *Mosla punctulata* NAKAI, comb. nov.
21. *Cardamine torrentis* NAKAI, nom. nov.

III. Not sufficiently known plants:—
1. *Arisæma amplissimum* BLUME
2. *Arisæma angustatum* FRANCHET & SAVATIER
3. *Arisæma sikokianum* FRANCHET & SAVATIER
4. *Chrysanthemum indicum* LINNÆUS
5. *Sorbaria stellipila* SCHNEIDER, and its variety *incerta*
6. *Atractylis ovata* THUNBERG
7. *Atractylis lancea* THUNBERG
8. *Ocymum rugosum* THUNBERG
9. *Ocymum virgatum* THUNBERG.

IV. Plants new to the Flora of Japan or Korea:—
1. *Chrysanthemum sibiricum* FISCHER—Japan
2. *Spiræa chinensis* MAXIMOWICZ—Korea
3. *Benzoin sericeum* SIEBOLD & ZUCCARINI—Korea.

**201. Violæ ad Floram Japonica Novæ.** Takenoshin NAKAI. (Bot. Mag. Tôkyô, **42**, 1928, 556–566).

This paper deals with the following new species and varieties of the genus *Viola* found in Japan, and also a number of known species of *Viola* newly found in Japan.

1. *Viola pubescens* AITON, found in the Kuriles
2. *Viola brevistipullata* BECKER var. *pubescens* NAKAI
3.  „           „                var. *acuminata* NAKAI
4. *Viola Carlesii* NAKAI
5. *Viola yesoensis* MAXIMOWICZ var. *discolor* NAKAI
6. *Viola hirtipes* S. MOORE var. *rhodovenia* NAKAI
7. *Viola phalacrocarpa* MAXIMOWICZ var. *pallescens* NAKAI
8. *Viola kisoana* NAKAI
9. *Viola Oldhamiana* NAKAI
10. *Viola primulifolia* LINNÆUS, found in Yeso, Saghalin and the Kuriles
11.  „            „                „       found in Korea and Japan
12. *Viola pseudo-japonica* NAKAI
13. *Viola Selkirki* PURSH. var. *laciniata* NAKAI
14. *Viola sacraricola* NAKAI
15. *Viola Rossi* HEMSLEY var. *lactiflora* NAKAI
16.  „       „      var. *atro-purpurea* NAKAI
17. *Viola Hideoi* NAKAI var. *robustior* NAKAI
18. *Viola Wichurai* NAKAI
19. *Viola Miyakei* NAKAI
20. *Viola pruniflora* NAKAI
21. *Viola kitamiana* NAKAI
22. *Viola blanda* WILLDENOW, found in the Kuriles
23. *Viola crossa* MAKINO var. *vegeta* NAKAI.

**202. Flora Sylvatica Koreana, pars XVII.** Takenoshin NAKAI. Publ. by the Forest Experiment Station, Government General of Chosen. 1928, 22 pls.

Critical studies have been made on Elæagnaceæ, Alangiaceæ, Daphnaceæ, Flacourtiaceæ, and Ternstroemiaceæ of Korea. Principal literatures are cited; the historical investigation of each plant, their uses, new classifications and descriptions of all plants, and Japanese and Korean names referable to their scientific names are found in each family.

Plants mentioned in the paper are as follows:

*Elæagnus crispa* THUNBERG var. *typica* NAKAI, var. *parvifolia* NAKAI, var. *coreana* NAKAI; *Elæagnus glabra* THUNBERG, var. *oxyphylla* NAKAI; *Elæagnus macrophylla* THUNBERG; *Elæagnus Nikaii* NAKAI; *Elæagnus submacrophylla* SERVETTAZ; *Elæagnus maritima* KOIDZUMI; *Marlea macrophylla* S. & Z. var. *trilobata* NAKAI; var. *velutina* NAKAI; *Marlea platanifolia* S. & Z. var. *typica* MAKINO; *Morlea sinica* NAKAI; *Diplomorpha trichotoma* NAKAI; *Daphne kiusiana* MIQUEL; *Daphne Genkwa* S. & Z.; *Daphne kamtschatica* MAXIMOWICZ; *Xylosma Apactis* KOIDZUMI; *Idesia polycarpa* MAXIMOWICZ; *Stewartia koreana* NAKAI; *Thea sinensis* L. var. *bohea* SZYSZYLOWITZ; *Camellia japonica* L. var. *spontanea* NAKAI; *Sakakia*, gen. nov.; *Sakakia ochnacea* NAKAI; *Eurya emarginata* MAKINO; *Eurya japonica* THUNBERG var. *montana* BLUME, var. *integra* NAKAI, *aurescens* REHDER & WILSON; *Ternstroemia Mokof* NAKAI.

The distribution of above plants is illustrated by eleven text maps. Twenty-two copper plates suffixed show the external and analytical figures of all species.

**203. Untersuchungen über die Keimung der Samen einiger Wasserpflanzen.** Yôzô NAKAJIMA. (Bot. Mag. Tôkyô 42, 1928, 576–591).

Der Verf. hat über die Samenkeimung der folgenden Wasserpflanzen eine Reihe von Versuchen ausgeführt: *Alisma Plantago aquatica* var. *angustifolia, Sagittaria sagittifolia* subsp. *sagitta* var. *hastata, Ottelia alismoides, Monochoria Korsakovii, M. vaginalis* var. *plantaginea.*

Die Samenkeimung der oben genannten Wasserpflanzen findet kaum im gewöhnlichen Keimbette und unter den gewöhnlichen Keimungsbedingungen statt. Als vermutlich in der Natur die aus der Mutterpflanze ausgetrennten Samen dieser Wasserpflanzen sofort unter Wasser sinken dürfen, hat der Verf. die Versuche gemacht, wobei die Samen unter Wasser gelegt werden: die Keimung geschah dabei ebensowenig statt wie bei den anderen. Nun hat der Verf. eine Methode entdeckt, wodurch man die obengenannten Samen leicht zur Keimung bringen kann. Wenn man nämlich die in PETRIschale auf Watte gelegten Samen dicht mit Deckglas bedeckt (ohne Luftblasen unter demselben!) tritt die Keimung bald ein bei *Ottelia* und *Monochoria vaginalis* ohne weiteres (d. h. aus dem Wasser herausgenommen und sofort behandelt), und auch bei *Alisma* und *Monochoria Korsakovii,* wenn nachdem sie einiger Zeit an der Luft getrocknet worden sind. Das Bedecken der Samen mit Deckglas verursacht natürlich den Luftmangel um dieselben herum, und es wird nicht unmöglich sein, dass diese Tatsache zur Beschleunigung der Keimung beitragen kann. Zum Beweis dafür konnte der Verf. eine mehr oder minder grosse Beschleunigung der Keimung unter dem luftfreien Wasser beobachten. Auch im letzteren Falle konnte der Verf. eine ziemlich beträchtliche Alkoholbildung nachweisen; nach dem Verf. mag zwischen dieser Alkoholbildung und der Keimung irgend eine Beziehung bestehen.

### 204. On the Number of Chromosomes in *Diospyros Kaki* L. f. and *Diospyros Lotus* L. Isawo NAMIKAWA. (Bot. Mag. Tôkyô **42**, 1928, 436–438, 6 figs.).

The number of chromosomes in the pollen mother-cells and root-tips of *Diospyros Lotus* and several cultivated varieties of *D. Kaki* was counted. In *D. Lotus* n=15 and 2n=30 were observed. In several varieties of *D. Kaki* the haploid number 45 and the diploid number 90 were counted.

### 205. Reduction Division in *Lycoris*. (Japanese with English résumé). Ichizô NISHIYAMA. (Bot. Mag. Tôkyô **42**, 1928, 509–513, 3 figs.).

*Lycoris sanguinea* and *radiata* are commonly met with in Japan as wild plants. It is well known that though the former bears seeds, the latter never produces them. The cytological investigation of the author has revealed the following facts. The haploid and diploid number of chromosomes in *L. sanguinea* are 11 and 22 respectively, and in the reduction division of pollen mother-cells 11 bivalents are found which behave quite normally. In *L. radiata*, on the contrary, the diploid number is 33, and in the reduction division of the pollen mother-cells the author has observed, for instance, besides 10 trivalents 1 bivalent and 1 monovalent. It is clear that the sterility of *L. radiata* is chiefly due to the irregular meiotic division.

### 206. Preliminary Notes on a New Helminthosporiose of Wheat. (*Triticum vulgare* Vill.). (Japanese with English résumé). Yosikazu NISIKADO. (Ann. Phytopathol. Soc. Japan **2**, 1928, 89–98, 2 pls.).

The yellow blight of wheat leaves caused by a species of *Helminthosporium*

which had never been recorded before has been discovered by the author. The causal fungus is a species, *H. tritici-vulgaris*. Its parasitic nature has been ascertained by inoculation experiments in wheat leaves. Its diagnosis is given in detail.

### 207. Studien über die Helminthosporiose von japanischen Gramineen.

(Japanisch mit englischen Diagnosen von neuen Pilzarten.). Yosikazu NISIKADO. (Spezielle Mitteil. aus Ôhara Inst. landw. Forsch. Nr. 4, 1928, 395 S. und 62 Taf.).

Dieses Werk besteht aus 14 Kapiteln, von denen jedes im allgemeinen weiter zu den Abschnitten eingeteilt wird. Die vier ersten Kapiteln beziehen sich auf die allgemeine Erörterung der Gattung *Helminthosporium* und der dadurch bedingten Krankheit, Helminthosporiose. Das nächste Kapitel wird der ausführlichen Beschreibung verschiedener Arten der Helminthosporiosen auf verschiedene Getreidearten, wie Gerste, Weizen, Mais und viele wildwachsende Gramineen gewidmet. Die nachfolgenden Kapiteln behandeln die Askosporengeneration, die kulturellen Eigenschaften, die Reaktionen gegenüber Temperatur und Wasserstoffkonzentration, die Wirkung auf das Wirt, die Kontrollmethode, die Sterilisation von Samen, usw. Die Diagnosen der folgendenden neuen Arten sind in English angegeben: *Helminthosporium tritici-vulgaris*, *H. panici-miliacei*, *H. Yamadai*, *H. Brizae*, *H. Coicis*, *H. Miyakei*, *H. Leptochloae*, *H. Zizaniae*, *Ophiobolus Kusanoi*.

### 208. On the Netbloch Disease of Barley.

(Japanese). Yosikazu NISIKADO and Chuichi MIYAKE. (Agric. & Hortic. 3, 1928, 1003–1016, 1 pl.).

The netbloch disesae of Barley caused by *Helminthosporium teres* SACC. (=*Pyrenophora teres* (SACC.) DRECHSLER) is clearly distinguishable from the spot-disease due to *H. gramineum* RAB. by the presence of dark lines forming the network. The causal fungus is distinguished from *H. gramineum* by the size, colour and number of septa of conidia. The conidia are arranged in chain as in *Alternaria*, which was never observed in any other *Helminthosporium*. It is clear that the ascigerous generation which was taken for that of *H. gramineus* really belongs mostly to the present fungus.

### 209. Cytological Studies on a Case of Pseudogamy in the Genus *Brassica*.

Yakichi NOGUCHI. (Proc. Imp. Acad. 4, 1928, 617–619, with figs.).

The hybrid, *Brassica campestris* var. *Aoleifera×B. oleracea* var. *gemmifera* is entirely maternal in its external features, though the experiments have disproved the occurrence of parthenogenesis. The cytological study of this hybridization has revealed the following facts. Of the two male nuclei one comes very near to the egg cell, and the other near to two polar nuclei. They will not fuse with them respectively. They may remain intact even for 24 hours, till finally they come to degeneration. The egg cell goes then to the embryo-formation.

The author thinks this to be a case of pseudogamy caused by the action of male nucleus which does not fuse with the egg nucleus, but simply stimulates the development of egg to embryo.

### 210. Icones Filicum Japoniæ. Vol. I.

Masasuke OGATA. Tôkyô, 1928, 50 pls., 38.2×26.0 cm, each with one explanatory page.

In "Icones Filicum Japoniae" the author will publish in several volumes the

illustrations of the Japanese Ferns which were drawn by the author himself. Vol. I which has lately been issued and which contains 50 plates illustrates 50 species belonging to 25 genera. Each plate is devoted to one species, and there are represented besides its whole habit also its sori, sporangia, spores, scales, cross-sections of rhizomes and petioles, etc. more or less magnified. The description is in Japanese, and the explanation of figures both in Japanese and English.

**211. On the Systematic Importance of the Spodiograms of the Leaves of the Bambusaceae (IV)-(V).** (Japanese). Kiichi OHKI. (Bot. Mag. Tôkyô **42**, 1928, 387-395, 2 figs.; 514-524, 2 figs.).

This is the continuation of the author's studies on the classification of the Bambusaceae according to their "Aschenbild." The following species are included in these two parts: *Sasa coreana, S. hannoensis, S. hiratsukaensis, S. tyuhgokensis, S. iyoensis, Pleioblastus linearis, P. Usawai, P. Kunishii, and P. variegatus.*

**212. Zur Cytologie der Gattung *Prunus*.** Sakuichi OKABE. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. (Biol.) **3**, 1928, 733-745, Abb.).

Der Verf. hat bei einer grossen Anzahl von *Prunus*arten,-varietäten und -rassen die Zahl der somatischen Chromosomen bestimmt. Danach beträgt sie meistens 16, selten 32 (=tetraploid) und 24 (=triploid). Auch wurde ein Fall der Hypertriploidie (25=3×8+1) aufgefunden. Die Gestalt der somatischen Chromosomen ist meistens ellipsoidisch und kurz, in der Mitte eingeschnürt.

Die Reduktionsteilung bei den Pollenmutterzellen von diploider und tetraploider *Prunus* geht ziemlich regelmässig vor sich. Bei der triploiden *Prunus* geschieht die Verteilung der Chromosomen nach den beiden Polen ganz zufällig, z.B. 8+16, 9+15, 10+14, 11+13, oder 12+12 in verschiedenen Fällen.

**213. Study of *Euryale ferox* Salisb. II. On the Variation in the Shape of the Seed.** Yônosuke OKADA. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. (Biol.), **3**, 1928, 581-586, 1 pl.).

Seeds of *Euryale ferox* from various localities were compared. It was found that they are either long or short, and provided with either warty or smooth coat. The author is inclined to the view, that such variations are not merely due to the environment but genotypic.

**214. On a Case of Sap Bleeding of *Cornus controversa* Hems. Observed at Sendai.** Yônosuke OKADA. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. (Biol.) **3**, 1928, 673-677, 1 fig.).

An English translation of the paper published in Japanese in other place. (See Japan. Jour. Bot. 3, (45), No. 129).

**215. Further Investigation on the Cytology of *Rumex*.** (Japanese with English résumé). Tomowo ONO. (Bot. Mag. Tôkyô **42**, 1928, 524-533, 30 figs.).

The formation of the embryo-sac in *Rumex Acetosa* is quite normal. In the megaspore mother-cell seven gemini are seen, of which one is larger than the others and considered to be the XX-pair. The further process goes normally. Double fertilization was observed. Embryos are either 14- or 15-chromosomic.

In *R. Acetosa* one female with 21 chromosomes (=triploid) was found; its chromosomic formula should be 21=18+3X= ♀(12+2X)+ ♂(6+X).

In the heterotypic division of pollen mother-cells in intersexual plants of *R. Acetosa* possessing 22 somatic chromosomes (22=18+2X+2Y) 6 trivalents, one large XX-pair and two Y-elements appear. They are distributed equally to the two poles. The second division is abnormal, and four resulting pollen grains are abortive.

In the heterotypic division of pollen mother-cells the nuclear plates with unreduced chromosome number 15 are often observed; each chromosome splits normally in the anaphase, which may be perhaps related to the formation of tri- and tetraploid plants.

In *R. vesicarius* n=9, 2n=18, this basal number is the first one ever found in the subgenus *Acetosa*. In nearly related *Oxyria elatior* the haploid number in the pollen mother-cells is 7.

**216. On the Pollen-tube Growth in Some Species of *Brassica*.** Tsunetaro SASAOKA. (Res. Bull. No. 11, Imp. Hort. Exp. Sta. Okitu, Japan, 1928, 8 pp. and 4 pls.);

In the self-pollination of *Brassica oleracea* var. *capitata* and its crossing by Baby head (compatible cross!) the pollen germination and the behaviour of pollen-tube were studied and found to be normal. In either case was the pollen-tube clearly discernible in the specimens taken 26 hrs. after pollination. The cross of *B. oleracea* by *B. juncea* is incompatible: pollen does not germinate generally on the stigma of the female plants, and the pollen-tubes produced by few can hardly penetrate the stigmatic tissue.

**217. On the Wilt Disease of Camphor-tree.** (Japanese). Kaneyoshi SAWADA. (Rpt. Dendrol. Soc. Formosa No. **30**, 1928, 26-36, 1 pl.).

In Formosa the wilt disease is often observed in cultivated camphor trees which are generally more than ten years old. The causal fungus is *Fomes lamoensis* (MURR.) SACC. et TROTT. (=*Hymonochaete noxia* BERKELEY) which is also the cause of brown rot disease.

**218. On the Scientific Name of Red Rust of Onions.** (Japanese). Kaneyoshi SAWADA. (Rpt. Nat. Hist. Soc. Formosa **18**, 1928, 148-163).

The causal fungus of the red rust of onions in Japan is generally identified with *Puccinia Porri* (Sow.) WINT. The author came as the results of his own studies to the conclusion that this is not right and that the causal fungus is really to be considered as *P. Allii* (DC.) RUDOLPHI.

**219. Descriptive Catalogue of the Formosan Fungi, Part IV.** (Japanese.) Kaneyoshi SAWADA. (Rpt. Dpt. Agric. Gov. Res. Inst., Formosa No. **33**, 1928, 123 pp., 4 pls., 35 pp. index).

148 species of fungi (4 Phycomycetes, 10 Ascomycetes, 106 Basidiomycetes, 27 Fungi Imperfecti) are described with illustrations. The following are new: *Helicobasidium albicans* (on *Citrus*), *Verticillium agaricicolum* (on *Agaricus*), *Cercospora acaciae-confusae*, *C. Alternantherae-nodiflorae*, *C. Jussiaeae-repentis*, *Gibellula Araneae*.

**220.** Studies on the "Bakanae"-disease of the Rice-plant I. A Consideration of the Occurrence of the "Bakanae"-disease and the "Bakanae"-phenomenon. (Japanese with English résumé). Fusataro SETO. (Ann. Phytopathol. Soc. Japan **2**, 1928, 118–139, 2 figs.).

The contents of this paper nearly coincide with those of the paper previously published by HEMMI and the author in Proc. Imp. Acad. **4**, 1928, 181–184. (Cf. Japan. Jour. Bot. **4**, 1928, (33), No. 86).

**221.** The Reactions of Rice-seedlings to Infection of the Causal Fungus of the "Bakanae"-disease and the Filtrates of its Cultures. Fusataro SETO. (Mem. Coll. Agric. Kyoto Imp. Univ. No. 7, 1928, Art. 2, 23–38, 2 pls.).

See Japan. Jour. Bot. **4**, 1928, (33), No. 86.

**222.** Karyokinese im Oogonium von *Cystophyllum sisymbrioides*, J. Ag. Naomasa SHIMOTOMAI. (Sc. Rpts., Tôhoku Imp. Univ. 4th Ser. (Biol.) **4**, 1928, 577–579, 2 Textabb.).

*Cystophyllum sisymbrioides* ist diözisch, wobei die Oogonentleerung simultan und periodisch am bestimmten Tage vor sich geht. In jedem Antheridium wird neben den Spermatozoiden ein farbloser, kugeliger Körper gebildet, dessen Natur noch unbekannt ist. Das Spermatozoid ist durch den Besitz eines orangeroten Augenfleckes ausgezeichnet, wie es auch bei *Fucus* und *Coccophora* der Fall ist. Im Oogonium findet die dreimalige Kernteilung sukzessiv statt, wobei die erste heterotypisch ist. Die Spindel ist intranukleär, und an jedem Pol ist je ein deutliches Zentrosom nachweisbar. Die haploide Zahl der Chromosomen ist 32.

**223.** On the Dioecism of Garden Asparagus (*Asparagus officinalis* L.) Takewo SHOJI and Toyobumi NAKAMURA. (Japan. Jour. Bot. **4**, 1928, 125–151, 49 text-figs.).

**224.** Influence des Proportions relatives des Hydrates de Carbone et de l'Azote sur la Croissance des Boutures de Tomates. (En japonais). Makoto SISA. (Agric. et Hort. **3**, 1928, 1422–1431, 4 figs.).

L'auteur a fait quelques expériences sur le développement des branches et racines chez les boutures de Tomates. L'étude a porté sur l'influence qu'en exercent les proportions relatives des hydrates de carbone et de l'azote, que l'on appelle récemment le quotient $\dfrac{C}{A_z}$. Les boutures employées pour les expériences étaient prises sur quatre cultures suivantes : 1° celles contenant peu d'hydrates de carbone, mais beaucoup d'azote, prises des plantes cultivées en dedans de la chambre pour éviter la lumière directe du soleil et fumées richement avec du salpêtre du Chili, 2° celles contenant tous les deux en grande quantité, prises des plantes bien exposées à la lumière et fumées plusieurs fois avec du salpêtre, 3° celles contenant beaucoup d'hydrates, mais moins d'azote que les dernières, parce qu'on en a données seulement la moitié du salpêtre, et 4° celles contenant beaucoup d'hydrates, mais très peu d'azote, prises des plantes cultivées sur le sable stérile que l'on a arrosé avec du liquide contenant tous les sels minéraux nécessaires pour la nutrition, sauf des sels azotés. Les expériences sur toutes ces boutures ont montré que le développement des racines est beaucoup plus vigoureux que ne l'est celui des

branches aériennes, lorsqu'il y en a beaucoup d'hydrates, mais peu d'azote, tandis qu'au cas contraire celui de celles-ci l'emportera. Il a été de plus démontré que, si l'on donne aux boutures riches en hydrates du liquide nourricier, on voit ou le développement prédominant des branches ou celui des racines respectivement, selon qu'il contient des matières azotées ou non.

**225. Studies on the Rice Blast Disease.** (Japanese). Heisiti SUEDA. (Rpt. Dpt. Agric., Gov. Res. Inst. Formosa, No. **36**, 1928, 130 pp., 5 pls. and 3 text-figs.).

This paper concerns the causal fungus of the rice blast disease, *Piricularia Oryzae*. It contains the results of very detailed investigations, of which few only can be referred in this short abstract.

The symptoms of this disease are most conspicuous in leaf-blades and panicles, but observable also on caryopses, young roots and buds, leaf-sheaths, culm-nodes as well as flower-stalks.

The size of conidia is variable according to different moisture and temperature: under warm and moist condition they are large and narrow, while under reverse condition small and broad. For the formation of each conidium on the conidiophore in dark place 5–10 minutes are necessary, and during one night more than ten conidia may be developed on one conidiophore. Conidia may come to germination 12–16 hrs. after the moment when they begin to be produced on the conidiophore. Their germination can take place between 15–20°C, the optimum being 25–28°C. Conidia produced under dry condition may germinate better than those formed under moist condition. When very moist, conidia are unable to germinate, though when dry condition is restored they are able to germinate. The nature of nutrient media has some influence on the germinating power: they germinate better under acid than under alkaline reaction, while they as well as hyphae grow better under the latter than under the former.

Sunlight exercises the great influence in every stage of development, especially direct sunlight much delays the germination as well as the growth. Both conidia and hyphae are pretty resistant against high temperature under dry condition. When conidia are subjected to 60°C during 30 hrs., one half portion of the conidia experimented upon dies off, while when they are placed in warm water of 50°C during 13–15 min. all of them die.

When conidia germinate appressoria are produced generally at the apex of germ-tubes. The appressoria, which were taken generally for chlamydospores are thick-walled cells secreting mucilaginous substance, by which they can adhere to certain parts of hosts. The germ-tubes and appressoria enter the host through stomata and epidermal cells themselves. Conidia may live pretty long: thus it was observed that they may survive for one year on the host's body out-of-doors or even for two years in nutrient media. They may live pretty long floating on the water surface of rice-field, but will die within two weeks, when they sink under water.

Various methods of control are discussed. (Cf. KURIBAYASHI, (62), No. 189.—Ed.).

**226. Chromosome Number in Some Higher Plants, I.** Toranosuke SUGIURA. (Bot. Mag. Tôkyô **42**, 1928, 504–506).

The chromosome number in pollen mother-cells (either hetero- oder homotypic division) of the following plants was counted: *Calceolarai mexicana* (x=30), *Daph-*

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*niphyllum macropodum* (x=16), *Nemophila insignis*, *N. maclata*, *N. discoidalis*, *Phacelia congesta*, *Primula malacoides*, *P. Forbesii*, (in above seven species x=9), *Pleuropteropyrum Weyrichii* (x=10).

The chromosome numbers in the root-tip cell in the following plants are counted: *Persicaria perfoliata*, *P. glandulosa*, *Amblygonon orientalis*, *Zingiber officinale* (in above four species 2x=22), *Persicaria Thunbergii* (2x=ca. 34), *Epipactis falcata* (2x=24).

### 227. Cytological Studies on *Tropaeolum* II. *Tropaeolum peregrinum*. Toranosuke SUGIURA. (Bot. Mag. Tôkyô 42, 1928, 553–556, 18 text-figs.).

In *Tropaeolum peregrinum* the diploid number of chromosomes is 24, i.e. 4 chromosomes less than in *T. majus*. According to the author's studies on pollen mother-cells no parallel arrangement of nuclear threads are observed in the early prophase of the heterotypic division. The nucleolus produces a number of buds. They are observable in the second contraction, but thereafter they are no more visible, whence the author thinks that the budded nucleoli are concerned in the formation of chromosomes. The meiosis goes otherwise quite normally. The method of pollen-tetrad belongs to the simultaneous type.

### 228. Contributions to Morphology of *Coccophora Langsdorfii* (Turn.) Grev. Masato TAHARA. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. (Biol.) 3, 1928, 727–732, 1 pl. and 5 text-figs.).

*Coccophora* is dioecious. Sexual cells are discharged simultaneously and totally during a few days of April. The sperm having one eye-spot and two flagella directed fore- and backwards resembles that of the Fucaceae. In one oogonium one egg is produced which is provided with one central nucleus. In the oogonium four nuclei are at first produced by two successive divisions, and three of them degenerate; this fact differs from what we see in *Sargassum*, where eight nuclei are produced by three successive divisions. The antheridia are, not only singly, but sometimes two or three connected together in a row, borne on filamentous branches. The eggs discharged from the conceptacle remain attached to the outer surface of the receptacle, and proceeds towards the embryonal development.

### 229. On the Chromosome Numbers of *Pelargonium*. Fumi TAKAGI. (Sc. Rpts. Tôhoku Imp. Univ., 1928, 4th Ser. (Biol.) 3, 1928, 665–671, 5 figs.).

In several species of *Pelargonium* the diploid and haploid chromosome numbers were found to be 16(8), 18(9), 36(18), 45, 81, 90(45). In *P. zonale* a few cells with 72 chromosomes (tetraploid) were found. In midwinter non-conjunction occurs in the reduction division of the pollen mother-cells growing in a greenhouse, so that sometimes a large number of dyads are produced instead of tetrads.

### √230. On the Arrangement of Cambial Cells in Some Woody Plants. Masahiko TAKAMATSU. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. (Biol.) 3, 1928, 615–621, 2 pls.).

The author distinguishes four kinds of the arrangement of cambial cells, viz. 1. regularly stratified cambium, where all cells which are rather short are arranged regularly in horizontal layers, 2. slightly stratified one, where cells which are larger than in 1 are so arranged that the line connecting the apices of the cells in the

same horizontal line is not straight, and the overlapping of each cell is shallow, 3. non-stratified one, where cells are much larger than in 2, the horizontal arrangement is not perceptible, and the overlapping of each cell is prominent, and 4. irregular cambium, where cells are still larger than in 3, and the overlapping of each cell is most obvious. A certain number of woody plants belonging to each of these four classes are enumerated. It may be said generally that the highly specialized plant families of Dicotyledons have regularly stratified cambium.

**231. On the Arrangement of Bast Elements in Conifers.** Masahiko TAKA-MATSU. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. (Biol.) **3**, 1928, 821–826, 1 pl.).

The author has studied the arrangement of bast elements in the Coniferae, including 30 species belonging to 11 genera. The fundamental form of the arrangement was found in some species of *Chaemaecyparis*, *Podocarpus*, *Thuyopsis*, etc. In this form the three tangential layers of thin-walled cells come between the two tangential layers of bast-fibres, and of the former layers the middle consists of reserve parenchyma cells and the two others of sieve-tubes. Various deviations from this fundamental type occur, which consist in the transformation of bast fibres into a layer of reserve parenchyma or sieve-tubes. According to the varying number of fibre-layers thus transformed 7–31 layers of thin-walled cells are observed between the two layers of bast-fibres.

The bast elements are arranged regularly in radial and tangential direction. *Torreya* is an exception to this rule, because the author could see no regularity of arrangement in this genus, reserve parenchyma, bast fibres, and sieve-tubes being in the state of confused mixture.

**232. On the Plant Communities in the Middle Part of the Island of Urup in the Kuriles.** Misao TATEWAKI. (Bot. Mag. Tôkyô **42**, 1928, 426–436, 4 photos.).

The island of Urup extends from 45°33′ to 46°13′ N. L. and from 149° 24′ to 150° 34′ E.L. The author distinguishes the following seven main associations: Forest-, sea-shore-, heath-, grassy land-, herbaceous land-, aquatic-, and swamp- and-bog-Association.

Each Association is generally divided into a number of subdivisions. In respect to each the characteristic plants are enumerated.

**233. Embryological Studies on *Oryza sativa*.** Shinichi TERADA. (Jour. Coll. Agric., Hokkaido Imp. Univ., Sapporo **19**, 1928, 245–260, 4 pls.).

The embryo-sac develops in normal way from the lowermost cell of the tetrad. The ovule is anatropus. The fertilization takes place $\pm$ 12 hrs. after anthesis; the occurrence of double fertilization is probable. The antipodals which are at first three in number increase by division, the maximum being less than ten. The primary endosperm nucleus formed by triple fusion undergoes several consecutive divisions before the fertilized egg cell has reached the metaphase of its first division. The endosperm tissue cells are at first filled with a dextrine-like substance before the appearance of starch grains. About one day after anthesis a two- to five-celled embryo is formed.

**234. Bastardierungsversuche bei *Brassica* und *Raphanus*.** Yasufusa TERA-

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SAWA und Naomasa SHIMOTOMAI. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. (Biol.) **3**, 1928, 827–841, 2 Tafeln und 4 Textabb.).

Unter verschiedenen Bastardierungsversuchen von *Brassica*sippen gab derselbe unter den Sippen mit 10 haploiden Chromosomen untereinander intermediäre Bastarde, welche in der nächsten Generation zu vielen Formen aufgespalten sind. Bei der Kreuzung unter den Sippen mit 9, 10 und 18 haploiden Chromosomen, und zwar mit ungleicher Chromosomenzahl sind die mütterlichen Bastarde, entweder fertil oder steril, entstanden, von denen die ersteren in der nächsten Generation wieder die mütterlichen Nachkommen ausgaben.

Bei der Kreuzung *Brassica chinensis* ♀ × *Raphanus sativus* ♂ war der Bastard intermediär und selbststeril. Bei *B. pekinensis* ♀ × *R. sativus* ♂ war der Bastard mütterlich und die daraus entstandenen Nachkommen waren wieder mütterlich.

Was die Untersuchungsresultate über die zytologischen Verhältnisse anbetreffen, wurde es vor allem beobachtet, dass bei den Bastarden zwischen zwei 10-chromosomigen Sippen die Reduktionsteilung in den Pollenmutterzellen ganz normal verläuft. Bei dem Bastard, *Brassica campestris* ♀ (mit 10 Chromosomen) × *B. juncea* ♂ (mit 8 Chromosomen) hat der Verf. festgestellt, das dieser Bastard 28 Chromosomen von der Zusammensetzung $10_2+8_1$ besitzt. Bei der Reduktionsteilung der Pollenmutterzellen ordnen sich dabei 10 bivalente an der Kernplatte regelmässig an, während 8 univalente unregelmässig zerstreut sind. Die letzteren erreichen dann die Kernplatte und erfahren die Spaltung. Bei der Metaphase der homötypischen Teilung beobachtet man 16–22 Chromosomen und bei der Anaphase scheinen alle die Aequationsteilung zu erfahren.

Bei den durch reziproke Kreuzung entstandenen Nachkommen, welche ganz mütterlich sind, stimmt die Chromosomengarnitur ganz mit derselben der Mutter überein.

Beim Bastard zwischen *Brassica* und *Raphanus* geht die Reduktionsteilung ganz unregelmässig vor sich, sodass oft die Dyaden und die anderen abnormen Gameten entstehen. (Vgl. MORINAGA, (64), Nr. 198.—Redaktion).

**235. On the Development of Two Races of *Valsa* in Relation to the Hydrogen-ion Concentration of Peach-trees.** (Japanese). Kôgo TOGASHI. (Agric. & Hort. **3**, 1928, 893–902, 2 figs.).

The author's study is concerned with two races A and B of *Valsa* which is the causal fungus of canker or die-back disease of peach-trees. The pressed out juice of healthy peach-trees indicates ± 5.0 pH. In their cortex the pH-value is very variable (4.4-5.6); in the medullary rays, in the cortex (4.4-5.0), and especially in the cambium (4.4-4.6) the acidity is high; in the bast it is low (5.0–5.8). The artificial culture shows that both races of *Valsa* develop best in slightly acid media (A pH ± 5.5, B ± 6.0). Though the author could not find the isometabolic point (SIDERIS) in its strict sense, it was clearly seen that the fungus is able to lead the nutrient media at first towards more acid side, and then back towards the alkaline. In diseased tissues of peach-trees the hydrogen-ion concentration is higher than in normal ones, for instance, the author has observed 4.4–4.6 pH or even 3.6–3.8 in certain diseased tissues.

**236. Three *Fusaria* which cause the Wilt Disease of Pea.** Kôgo TOGASHI. (Japan. Jour. Bot. **4**, 1928, 153–188, 5 pls. and 1 text-fig.).

**237. Jurassic Plants from the Fang-tsu Coal-field, Shantung.** Hisakatsu YABE and Saburô ÔISHI. (Japan. Jour. Geol. & Geogr. **6**, 1928, 14, 4 pls.).

The following species are described with illustrations: *Equisetites* sp., *Cladophlebis haiburnensis, C. denticulata, Coniopteris hymenophylloides, C. burejensis, Ginkgo sibirica, Baiera asadai* (n. sp.), *Czekanowskia rigida, Pityocladus shantungensis* (n. sp.), *Pityophyllum nordenskiöldi.*

**238. A New Species of *Protoblechnum* from the Hei-shan Coal-field in Shantung.** Hisakatsu YABE and Saburô ÔISHI. (Japan. Jour. Geol. & Geogr. **6**, 1928, 15–17, 1 pl.).

A new species *Protoblechnum hallei* is described and illustrated.

**239. A New Species of *Sphenophyllum* from Shansi, China.** Hisakatsu YABE and Saburô ÔISHI. (Japan. Jour. Geol. & Geogr. **6**, 1928, 51–52, 1 pl.).

*Sphenophyllum spinulosum* n. sp. is described and illustrated.

**240. A Note on *Problechnum wongii* Halle.** Hisakatsu YABE and Saburô ÔISHI. (Japan. Jour. Geol. & Geogr. **6**, 1928, 61–62, 1 pl.).

Specimens No. 1–4 of *Protoblechnum wongii* HALLE collected in the coal-bearing series of the Chang-chin coal-field, Shantung, China are described with figures.

**241. The Origin of Camphor in Camphor Trees.** Tomizo YAHAGI. (Japan. Jour. Chem. **3**, 1928, 109–129, 5 pls. and text-figs.; also Sc. Papers Centr. Res. Inst., Gov. Monopoly Bur. Japan No. **23**, 1928, 1–18, 5 pls. and text-figs.).

About the formation of camphor oil in camphor trees there prevails on one side the theory that the internal side of the membrane of oil receptacles (=resinogenous layer) becomes mucilaginous and gradually changes into oil (TSCHIRCH and SHIRASAWA), while on the other it is considered that the oily matter is first formed in green parts of the tree, circulates its body in solution and precipitates in oil receptacles (CHARABOT and GATIN). The author's experiments have first of all shown that the sap of the camphor tree never contains any perceptible amount of camphor, which disproves the contention made by the second of the two theories above mentioned. Through chemical as well as morphological studies the author has ascertained the existence of peroxydase along the inside wall of the oil cells (which may correspond to resinogenous layer of TSCHIRCH), especially in the woody tissues lying directly within the cambium. The formation of camphor products is apparently chiefly due to the action of that enzyme on the substance contained in the cells.

The formation of camphor and oil takes place in very early stage of the plant growth, which is just contrary to what has been hitherto held, viz., that the camphor may first be produced after the lapse of several years. Its formation goes parallel to the vigour of the growth.

The above observations may apply not only to camphor tree, but also equally to *Cinnamonum Loureiri* and *Laurus nobilis.*

**242. Report of the Biological Survey of Mutsu Bay. 9. Marine Algae of Mutsu Bay and Adjacent Waters. II.** Yukio YAMADA. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. (Biol.) **3**, 1928, 481–534, 25 figs.).

75 Chlorophyceae, 18 Phaeophyceae and 26 Rhodophyceae from Mutsu Bay and adjacent waters are contained. Many which are new are generally illustrated. The following are new species: *Gobia saxicola*, *Elachista taeniaeformis*, *E. tenuis*, *Halothrix ambigua*, *Dictyota spathulata*, *Dasya sessilis*.

### 243. On the Respiratory Pigment, Cytochrome, in Bacteria. Hidetaka YAOI and Hiroshi TAMIYA. (Proc. Imp. Acad. 4, 1928, 436–439).

By microspectroscopic studies of the culture of various bacteria, aerobic as well as anaerobic, it was found that a close parallelism exists between the cytochrome content and the intensity of aerobic respiration. Thus obligatory aerobic bacteria show the four characteristic bands for reduced cytochrome (*a*, *b*, *c*, *d*), and the facultative aerobic bacteria only 2 or 3 bands, while the obligatory anaerobic show no bands at all, thus revealing the absence of cytochrome.

### 244. Some Additional Experiments on the Fertility in *Petunia* L. (Japanese). Sadao YASUDA. (Bot. Mag. Tôkyô 42, 1928, 498–500).

From a stock of *Petunia violacea* which was placed in the greenhouse during the winter some branches were cut off and grown as cuttings. When the latter came to flowering the self-pollination of their flowers and their pollination by pollen taken from the original mother-stock were done, and the results were compared to each other. It was found that the result (rate of fertilization, size of ovaries not fertilized and yet grown somewhat, size and weight of seeds) is always better in the latter than in the former case of pollination.

### 245. Studies on *Pharbitis Nil* Chois. II. Chromosome Number. Kono YASUI. (Bot. Mag., Tôkyô 42, 1928, 480–485, 3 figs.).

The chromosome number in the pollen mother-cells in various strains of *Pharbitis Nil* which differ considerably in their external characters was determined, and found invariably to be 15. (Cf. NAGAO, (65), No. 199.—Ed.). Flowers and leaves in 11 strains are illustrated.

### 246. Einige Versuche über die Wirkung des Aluminiums auf die Pflanze. Yoshiji YOSHII. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. (Biol.) 3, 1928, 547–559).

Die Konzentration des Al-Ions, welche auf die Pflanzen die schädliche Wirkung ausübt, ist nach verschiedenen Arten verschieden, so z. B. wird *Aspergillus* schon in der Lösung von 0,005 mol. Konz. beträchtlich beschädigt, während *Penicillium* sogar in 1 mol. Konz. noch auskeimen kann. In verdünnter Lösung ist bei den Pilzen die Konidienbildung beschleunigt und man kann aus dem Erntegewicht auf die Reizwirkung des Al-Ions schliessen. Bei *Elodea* erkennt man die schädliche Wirkung schon bei 0,001 mol. Konz. Nach den Verfs. Versuchen mit abgeschnittenen Zweigen wurde es konstatiert, dass die 0,002 mol. Konz. schon eine merkliche Giftwirkung auf die höheren Pflanzen ausübt, während die geringere Konzentration fördernd wirkt. Viele in der Erde bewohnende Algen, wie *Chlamydomonas* können die starke Konzentration des Al-Ions vertragen, z.B. 0,25 mol. Konz.

### 247. Serological Identification of Yeasts. First and Second Report.

Entries 243–247

(Japanese with English résumé).  Matao YUKAWA and Masashi OHTA.  (Bult. Sc. Fak. Terk., Kjuśu Imp. Univ. **3**, 1928, 187–199 with figs.; do., 200–216).

The studies of various yeasts by various serological methods have revealed the following facts :—

*Zygosaccharomyces Barkeri* and *Debaryomyces globosus* are fairly closely related to each other.  *Endomyces fibuliger* acts positively almost in equal degree against *Zygos. Barkeri*, *Deb. globosus*, saké and beer yeast.  *Torula C* reacts positively against *Zygos. Barkeri*, *Deb. globosus*, saké and beer yeast, but negatively against *Endomyces fibuliger*.  *Schizosaccharomyces octosporus* reacts negatively against all yeasts taken for the present experiment.

Saké, wine and beer yeasts are indistinguishable from each other by "Ringprobe," which indicates that they are closely allied among themselves.  *Sac. turbidans*, *Sac. Pastorianus* and *Sac. validus* on one hand, saké, wine and beer yeasts on the other are placed under the same subgroup by HANSEN, and distinguished as pathogenic and useful yeasts from the industrial point of view respectively ; they are clearly distinguishable from each other serologically.  Also saké, wine and beer yeasts can be distinguished by "Absättigungsverfahren."  The varieties among saké yeast itself are distinguishable neither by "Ringprobe" nor by "Absättigungsverfahren."

# Abstracts Nos. 248–356

(Referring to the principal papers on Botany and allied subjects which
have appeared in Japan chiefly during January-June 1929)

**248.  An Anatomical Study of the Leaves of the Genus *Pinus*.** Tôhei Doi
and Kin-ichi MORIKAWA. (Jour. Dpt. Agric., Kyushu Imp. Univ. **2**, 1929, 149–198
with 5 figs.).

The authors intend to establish on the basis of the anatomical characters of
leaves a practical system of classification of the genus *Pinus* which will correspond
as closely as possible to the natural system.

The genus is first of all divided into Haploxylon and Diploxylon according to the
number of fibro-vascular bundles in leaves (1–2).  The distinguishing characters
which come next are 1. the presence and absence of sclerenchymatous cells and their
arrangement in relation to vascular bundles, 2. the shape of endodermis (circular,
triangular, etc., etc.) and the mode and form of thickening of its individual cells, 3.
the position of resin-canals, 4. the composition of hypodermis (1–3 layers, thin- or
thick-walled), and 5. the position of stomata (on ventral side only or on both ventral
and dorsal sides).  The subgenera, sections and subsections of *Pinus* in the second
edition of ENGLER's Nat. Pflanzenfam. are characterized according to the above
mentioned·distinguishing characters.

An analytical key of the genus on the basis of the anatomical characters which
comprises more than 140 species is given.

**249.  Ueber drei neue Arten der schwefeloxydierenden Bakterien.** Yoshi-
kazu EMOTO. (Proc. Imp. Acad. **5**, 1929, 148–151, 6 Abb.).

Drei neue *Thiobacillus*arten sind beschrieben und abgebildet, nämlich *lobatus*,
*crenatus* und *umbonatus*.

**250.  Ueber neue Myxomycetenarten.** (Japanisch m. deutsch. Zfg.).  Yoshi-
kazu EMOTO. (Bot. Mag. Tôkyô **43**, 1929, 169–172, 1 Taf.).

Beschreibung von zwei neuen Myxomyceten, *Clastoderma Debaryianum* BLYTT.
var. *imperatoria* var. nov. und *Diderma imperialis* sp. nov.

**251.  On the Growth Period when the Heading of Spring Barley is most
highly affected by Night Illumination.** (Japanese).  Nakae ENOMOTO. (Proc.
Crop Sc. Soc. Japan **3**, 1929, 32–37, 5 pls.).

It is well known that in the spring barley the heading is much accelerated when
it is illuminated artificially at night.  The author made a series of experiments to
determine the period of its growth when such illumination is most efficient for ac-
celerating the heading.  According to the author's results it is the first period of its
vegetation after the germination that the illumination acts most effectively, for in-
stance, only during 30 days after the germination, after which the effect lessens
gradually.

**252. Preliminary Report on *Brassica-Raphanus* Hybrids.** Eiji FUKUSHIMA. (Proc. Imp. Acad. **5**, 1929, 48–50, 10 figs.).

Three following crosses were made, viz. *Raphanus sativus* × *Brassica oleracea*, *B. cernua* × *R. sativus*, and *Brassica juncea* × *Raphanus sativus*. The F$_1$ hybrids are always sterile. The reduction division shows the irregular behaviour of the chromosomes and the produced pollen goes always to degeneration. In the first of these three hybrids 18 chromosomes (9 from each parent) make no bivalents, and form a few groups irregularly distributed, from each of which small nuclei are derived. Each of the latter gives rise to a dwarf microspore. In the second of the above mentioned F$_1$ hybrids 27 chromosomes (18 and 9 from each parent respectively) do not conjugate at all. 4–10 of these univalents split lengthwise in the first division and are distributed to both poles and in the second division each of these halves is again split lengthwise. In the third of the above mentioned F$_1$ hybrids 27 univalent chromosomes undergo no conjugation. In the first division some of the univalents are split lengthwise just as in the former case, but the halves thus produced do not split in the second division or even when split the resulting halves do not separate from each other.

**253. Genetic Studies of Flower-colours in Japanese Morning-Glories. III. Inhibiting Factors of the Factor concerning the Shade of Flower-colours.** (Japanese with English résumé). Tokio HAGIWARA. (Bot. Mag. Tôkyô **43**, 1929, 106–117).

The so-called dark-coloured shade produced by the presence of grayish colour is due to the action of the factors $K_1$, $K_2$, $k_1$, $k_2$, and the inhibiting factors $H^k$ and $K^k$ in various combinations.

**254. Genetic Studies on the Dominant White Flower in *Pharbitis Nil*.** Tokio HAGIWARA. (Bot. Mag. Tôkyô **43**, 1929, 133–145, 4 figs.).

Some white flowers in Japanese Morning-Glory (*Pharbitis Nil*) behave as Mendelian dominants, exhibiting the segregation ratio 3:1 or 15:1 in F$_2$. In some other crossings this ratio was found to be 61:1. The dominant whiteness is due to the action of two inhibitors.

The white-margined flower is caused by the action of an inhibitor which suppresses the colouring function of the factor **R** in the corolla margin. There is besides a flower having a pattern gradually becoming white from the centre towards the margin round the tube: this is due to the absence of the factor $S_f$ which will support the function of **R**. The function of the factor $S_f$ is inhibited by the action of $H_1$. There may be at least seven pairs of factors which act either totally or partially against **R** as inhibitors.

**255. Complementary Factors for Anthocyanin Development in *Pharbitis Nil* and Their Linkage Relations.** (Japanese). Tokio HAGIWARA. (Jour. Sc. Agric. Soc. Japan **316**, 107–126).

The author could distinguish in Japanese Morning-glory three distinct types of white-flowered plants, 1. green stem, coloured corolla-tube (**CCrr**), 2. coloured stem, pale yellow tube (**ccRR**), and 3. green stem, pale yellow tube (**ccrr**), in all of which

flowers are white. For the production of anthocyanin in corolla the coexistence of at least two complementary factors **C** and **R** is necessary, which are linked with 24–40% cross-over.

**256. A propos des Albinos chez l'Orge.** (En japonais). Siroku HARA. (Jour. Sc. Agric. Soc. Japan **318**, 217–222).

Le croisement de deux races d'orge tout à fait vertes a donné naissance en $F_2$ à une famille composée des plantes vertes et blanches en proportion 3:1. La culture de la descendance de ces plantes vertes en $F_3$ a donné non-seulement les familles composées de plantes vertes seulement et de celles contenant les deux sortes en proportion 3:1, mais encore celles où le nombre des plantes blanches est ou beaucoup plus grand ou plus petit qu'une contre trois vertes. La culture en $F_4$ a donné les résultats presque similaires qu'en $F_3$. L'auteur considère l'apparition des plantes blanches à être due originairement à la mutation **C**→**c**, où **C** est le facteur responsable pour le développement de chlorophylle. La disjonction des plantes vertes et blanches en proportion où le nombre de celles-ci est beaucoup plus petit qu'une contre trois sera due vraisemblablement à la mutation inverse **c**→**C**, qui peut avoir lieu fréquemment.

**257. Ueber die systematische Anatomie der Gattung *Sasa* Mk. et Shib.** (Japanisch). Bunzô HAYATA. (Bot. Mag. Tôkyô **43**, 1929, 23–48, 123 Textabb.).

Die genaue Bestimmung der *Sasa*arten (Bambuseæ) ist kaum möglich, wenn man nicht im Besitze der mit Wurzeln, Halmen, Blättern, Blüten und Früchten ausgestatteten vollkommenen Exemplaren ist. Indem aber es gewöhnlich sehr selten der Fall sein kann, hat der Verf. die in der vorliegenden Mitteilung erwähnten dankenswerte Arbeit unternommen, um durch die anatomischen Untersuchungen des Blattes diese Arten genau bestimmen zu können. Nachdem die Untersuchungsmethoden beschrieben sind, hat der Verf. eine sehr minutiöse illustrierte Beschreibung des anatomischen Baues der Blätter und Wurzeln von *Sasa borealis, S. paniculata, S. nipponica, S. albo-marginata* und *Shibatea Kumasasa* angegeben. Es wird natürlich unmöglich sein, hier alle diese Daten sogar kürzlich zu referieren. Doch möge unten bloss die Unterscheidungsmerkmale aller diesen Arten dank dem anatomischen Baue der Blätter erwähnt. *Shibatea Kumasasa* ist wegen des völligen Mangels der Kieselzellen an der oberen Oberhaut leicht unterscheidbar. Beide *Sasa paniculata* und *borealis* sind durch den Mangel der Stachelhaare an der oberen Oberhaut charakterisiert; diese zwei sind voneinander durch die Tatsache unterscheidbar, dass während bei der unteren Oberhaut der ersteren die Stachelhaare sehr selten vorkommen, derselbe der letzteren ganz mit denselben bedeckt ist, ausgenommen an den Spaltöffnungsstreifen. *S. nipponica* ist durch das sehr reichliche Vorkommen der Kieselzellen an der oberen Oberhaut ausgezeichnet, während bei *S. albo-marginata* sie fast völlig mangeln.

**258. Microcibotium, a New Subgenus founded through the Consideration of the Stelar Structure of *Cibotium Barometz*.** (Japanese). Bunzô HAYATA. (Bot. Mag. Tôkyô **43**, 1929, 312–317, figs.).

*Cibotium Barometz*, formerly placed variously under *Polypodium, Aspidium, Nephrodium* or *Dicksonia* is characterized by lacking in its rhizomes the outer sheath composed of adventitious roots which are commonly seen in those of the Cyatheaceæ.

The author has created a subgenus Microcibotium for this species to distinguish it from the other species included under the subgenus Eucibotium. The anatomical structure of *Cibotium Barometz* was studied.

**259. Contributions to the Knowledge of the Systematic Anatomy of Some Japanese Plants.** (Japanese). Bunzô HAYATA and Yosisuke SATAKE. (Bot. Mag. Tôkyô **43**, 1929, 73–106, 10 text-figs.).

The anatomical features of the leaves of the Japanese Taxaceæ (*Torreya nucifera*), Pinaceæ (*Abies firma, homolepis, holophylla, sachalinensis, Veitchii, Tsuga Sieboldii, Picea polita, Glehni, jezoensis, Pinus koraiensis, parviflora*), Taxodiaceæ (*Sciadopitys verticillata*), Cupressaceæ (*Juniperus procumbens*), and Ericaceæ (*Phyllodoce nipponica, aleutica*) are studied in detail, and full illustrations are given. The literature ends the paper.

**260. Additional Notes on the Melampsoraceae of Saghalien.** Naohide HIRATSUKA. (Trans. Sapporo Nat. Hist. Soc. **10**, 1929, 119–121).

7 species are given for the first time. Of the 3 other species new hosts are given. (S. Japan. Jour. Bot. **4**, 1928, (33), No. 87).

**261. *Thekospora* of Japan.** Naohide HIRATSUKA. (Bot. Mag. Tôkyô **43**, 1929, 12–22).

7 species of Japanese *Thekospora* are enumerated with their hosts and their distribution in various localities in Japan. The analytical key is given.

**262. Chromosome Arrangement. III. The Pollen Mother-cells of the Vine.** Harushige HIRAYANAGI. (Mem. Coll. Sc., Imp. Univ. Ser. B **4**, 1929, 273–281, with figs.).

In several varieties of *Vitis vinifera* and *labrusca* the haploid chromosome number was found to be·19. When all chromosomes are arranged in the nuclear plate, the resemblance of their arrangement to that of MAYER's floating magnets was recognizable in 66.6 % of the cases observed. The arrangement which resembles the stable form of the grouping of 19 magnets is most frequently seen, i.e. that where 7 chromosomes appear in the middle ring (Cf. Entry 289 in this No.—Ed.).

**263. Studies on Some Downy Mildews of Agricultural Plants. I. On *Sclerospora graminicola* (Sacc.) Schroet., the Causal Fungus of the Downy Mildew of Italian Millet.** (Japanese with English résumé). Makoto HIURA. (Trans. Sapporo Nat. Hist. Soc. **10**, 1929, 146–156).

The conidia of *Sclerospora graminicola* on Italian millet are produced in every stage of the development of the host. The first infection stage is difficulty recognizable, because then a small indistinct patch occurs on the lower surface of the host's leaves. After a few days the latter are discoloured and shrivel down. The conidia are easily destroyed by dryness. Their germination gives rise to either zoospores or germ-tubes.

**264. Studies on Some Downy Mildews of Agricultural Plants. I. On** *Sclerospora graminicola* **(Sacc.) Schroet., the Causal Fungus of the Downy Mildew of Italian Millet. (The Second Preliminary Note).** (Japanese with English résumé). Makoto HIURA. (Jour. Sc. Agric. Soc. **319**, 1929, 245–253).

Though field observations on *Sclerospora graminicola* have shown that the conidia are developed apparently only during the night time, the author was able to let them produce in the laboratory during the day time. The most favourable condition for this process is the temperature varying from 17° to 21° and the complete water saturation of the atmosphere.

The conidia are forcibly discharged from the sterigmata, and the vertical distance of conidia thrown off by the discharging is 3 mm in maximum, but mostly less than 2 mm.

**265. Studies on Some Downy Mildews of Agricultural Plants. II. Relation of Meteorological Conditions to the Downy Mildew of Cucumber.** (Japanese with English résumé). Makoto HIURA. (Res. Bull. Gihu Imp. Coll. Agric. No. **6**, 1929, 1–54, 1–2).

The minimum temperature for the primary infection of the downy mildew of cucumber (*Peronoplasmospora cubensis*) lies between 10–15°C, while the optimum for the production of the disease is 20°C on the average. For its outbreak a certain amount of precipitation is indispensable. At about 30°C the disease begins to decline notwithstanding the presence of all other favourable conditions. For the conidia germination the optimum temperature lies between 15–19°C, the maximum being 30–32° and the minimum 4°. For the conidia production the maximum and the minimum are ± 27° and below 10°C respectively.

**266. On a New Leaf-spot Disease of the Japanese Persimmon Caused by** *Mycosphaerella Nawae.* (Japanese with English résumé). Makoto HIURA. (Res. Bull. Gihu Imp. Coll. Agric. No. **5**, 1–34, 1–2, 2 pls.).

Since about twenty years certain orchards of the Japanese persimmons are seriously damaged by a fungus disease which badly affects the leaves and leads to the falling of some fruits. The symptoms of disease are very similar to those of the leaf-spot caused by *Cercospora Kaki* ELL. et Ev., but are distinguished in certain respects, hence the fungus is newly called *Mycosphaerella Nawae* HIURA et IKATA. Its description is given.

**267. A Statistical Study on the Biological Forms of** *Erysiphe graminis* **DC.** (Japanese with English résumé). Yasu HOMMA. (Trans. Sapporo Nat. Hist. Soc. **10**, 1929, 157–161, 4 figs.).

The authoress could distinguish four following biological forms of *Erysiphe graminis* according to the size of the conidia, viz. f. sp. Tritici (on common wheat) 37.35 × 14.50, f. sp. Hordei (on naked barley) 35.45 × 14.64, f. sp. Poæ (on *Poa annua*) 31.00 × 16.31, and f. sp. Elymi (on *Elymus mollis*) 26.67 × 13.84. All above measurements are in μ.

**268. Nuntia ad Floram Japoniae II-III.** Masaji HONDA. (Bot. Mag. Tôkyô **43**, 1929, 189–193, 291–294).

Entries 264-268

The following plants are noticed: *Panicum dichotomflorum* MICHAUX, *Rhamnus costata* var. *nambuana* HONDA var. nov., *Persicaria iseana* HONDA, var. *stenophylla* HONDA, *Carex sacrosanta* HONDA, *C. Hayatae* HONDA nom. nov., *Gentiana saxatilis* HONDA nom. nov., *Calamagrostis Masamunei* HONDA sp. nov., *Arundinella riparia* HONDA, sp. nov., *Paederia chinensis* HANCE f. *microphylla* HONDA f. nov., *Carex pseudo-Wrightii*, HONDA sp. nov., *Sakakia ochnacea*, NAKAI var. *contracta*, HONDA var. nov., *Agropyron yezoense*, HONDA sp. nov., *Trisetum homochlamya*, HONDA sp. nov., *Parabenzoin praecox*, NAKAI var. *pubescens* HONDA var. nov., *Ischaemum Sakaguchii*, HONDA sp. nov., *Glyceria viridis*, HONDA sp. nov.

**269. Studies on the Hepaticae of Japan I.** Yoshiwo HORIKAWA. (Sc. Rt. Tôhoku Imp. Univ. 4th Ser. (Biol.) 4, 1929, 39–72, 4 pls. and 6 text-figs.).

The Japanese Hepaticæ known till now-a-days are in the number of 500 species and 90 genera, and of these about 65% are quite endemic. The author intends in a series of papers to make a description of these Hepaticæ with illustrations, and the present paper is the first one of them. The following Hepaticæ are described: *Reboulia hemisphaerica*, *Makinoa crispata*, *Schiffneria viridis*, *Pleurozia arcuata*, *Frullania densiloba*, *F. aoshimensis*, *F. tsukushiensis*, and *F. Makinoana*.

**270. Ueber die Resultate der Kreuzung von zwei *Plantago*arten.** Seiitirô IKENO. (Japan. Jour. Bot. 4, 1928, 9, 303–316, 3 Textabb.).

**271. Studies on the Development of Chromosomes in *Linum*.** (Japanese with English résumé). Choyo INOUYE. (Proc. Crop. Sc. Soc. Japan 3, 1929, 39-56, 1 pl.).

In the pollen mother-cells of *Linum usitatissimum* and *L. perenne* there are in the resting nucleus one large nucleolus and several chromatin granules representing the prochromosomes. In the beginning of the nuclear division the latter conjugate two by two, and the nucleolus produces one or more new nucleoli. The spirem network becomes connected with the nucleolus, and seems to receive chromatin from the latter. Hereafter it seems that the spirem gradually loses its chromatin, and attains the so-called achromatic strepsitene stage when we may observe in the nucleus almost exclusively achromatic threads, except in the nucleoli, where all chromatin is apparently preserved. After that the spireme begins to receive chromatin from the nucleoli.

The haploid number of chromosomes is 9 and 6 in *Linum perenne* and *usitatissimum* respectively.

**272. Ueber den Zusammenhang zwischen den Nukleolen und Kernfäden in den Pollenmutterzellen.** (Japanisch m. englischer Zfg.). Choyo INOUYE. (Proc. Crop Sc. Soc. Japan 4, 1929, 77–80, 1 Taf.).

Früher hat der Verf. bei den Pollenmutterzellen von *Linum* die Tatsache festgestellt, dass das in den Nukleolen aufbewahrte Chromatin allmählich nach den Kernfäden übergeführt wird, um damit die Chromosomen auszubilden (vgl. Nr. 271). Die Beobachtung an einer Anzahl von anderen Pflanzen, z.B. *Ricinus, Thea, Solanum, Lycopersicum, Phaseolus, Glycine, Allium* usw. führt den Verf. dabei zur gleichartigen Auffassung.

**273.** *Collybia Nameko*, **sp. nov.: a New Edible Fungus of Japan.** Tokutaro ITo. (Proc. Imp. Acad. **5**, 1929, 145–147, 6 figs.).

A description of an edible winter mushroom *Collybia Nameko* n. sp. generally found parasitic on *Fagus Sieboldii*.

**274. Studies of the Size of Chromosomes in Relation to the Phylogeny of Crop Plants.** (Japanese). Fuyuwo KAGAWA. (Proc. Crop Sc. Soc. Japan **3**, 17–24).

Taking into consideration the foreshortening of chromosomes under the microscope the author has measured the length of 14 chromosomes in the root-tip cells of *Triticum monococcum* by the aid of his projection method (cf. Cellule **37**). It was established, firstly that these 14 chromosomes form a series gradually passing from short to long which is quite constant for each cell, secondly that each chromosome shows one constriction at its middle point or nearabout, of which the position is constant for each, and thirdly that we found always one pair of chromosomes of the same length and with the constriction located at the same position. The ratio of the lengths of the shortest and the longest chromosomes was found to measure in average 100:68. In the root-tip cells treated by chloral hydrate the chromosomes thicken and shorten, and become much more easily measurable than in those fixed in ordinary way. It may be added that the treatment by that reagent does cause no change in the relative lengths of 14 chromosomes, and also the relative positions of constrictions, as compared with roots treated in ordinary way.

In the root-tip cells of *Triticum polonicum*, *T. dicoccum* (both tetraploid, 28 chromosomes) and *T. vulgare* (hexaploid, 42 chromosomes) the author has measured by the aid of projection method the lengths of chromosomes which are very probably the shortest and the longest ones in each cell. Their ratio lies in average between 49–54:100.

The *Triticum* species above mentioned, viz. *T. monococcum* (and *dicoccum*), *polonicum* and *vulgare* show the number of chromosomes equal to 2-, 4-, and 6-times the basic one 7 respectively. From the difference of the length ratios of the shortest and the longest chromosomes in *T. monococcum* and *polonicum* just mentioned and from the presence of only one pair, not two pairs, of the shortest chromosomes in *T. polonicum*, the author comes to the conclusion that the phylogenetic development of *T. polonicum* (and also *T. dicoccum* and *vulgare*) is not due to the reduplication of one and the same basic set of chromosomes from *T. monococcum* (autopolyploidy), but to a crossing between certain different ancestral plants (allopolyploidy), thus leading to the meeting of different kinds of chromosome sets in one cell.

**275. Natural Crossing in the Tomato.** (With Japanese résumé). Yôiti KAKIZAKI. (Japan. Jour. Genetics **4**, 1929, 81–85).

Two varieties of *Lycopersicum esculentum*, Ponderosa and Mikado, which are easily distinguishable from each other by the degree of dissection of their leaves were planted 40 cm apart in 80 cm rows. The rate of natural crossing was found to amount to 2.22%.

**276. Einige Beobachtungen über die Chromosomen von *Asparagus officinalis* L.** Iwao KAMO. (Bot. Mag. Tôkyô **43**, 1929, 127–133, 23 Textfig.).

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In den Pollenmutterzellen von *Asparagus officinalis* beträgt die Zahl der haploiden Chromosomen 10, welche aus 6 grossen und 4 kleinen bestehen. In der Metaphase der Reduktionsteilung sowie der somatischen lagern sich die grossen an der Peripherie und die kleinen in der Mitte. Die Längsspaltung für die zweite Teilung ist schon in der Metaphase der ersten nachweisbar. Auch ist die Paarung der Chromosomen in der Metaphase der somatischen Teilung zu beobachten. Es gibt keine Geschlechtschromosomen da.

**277. Etudes cytologiques sur les Convolvulacées.** (En japonais). Takayosi KANÔ. (Proc. Crop Sc. Soc. Japan **4**, 1929, 15–21).

Le nombre des chromosomes chez les Convolvulacées suivantes a été calculé par l'auteur. En bas ce nombre est indiqué entre les parenthèses, et il est généralement haploïde, excepté quelques cas: *Pharbitis Nil* (15), *P. hispida* (15), *P. hederacea* (15), *Quamoclit angulata* (15), *Q. vulgaris* (15), *Q. Sloteri* (30), *Calystegia Soldanella* (11), *C. sepium* var. *japonica* (11), *Calonyction bona-nox* ($2n = 30$), *Ipomaea edible* ($42$?), *Convolvulus tricolor* ($2n = 20$).

**278. On Some New Japanese Fungi.** Seiichi KAWAMURA. (Japan. Jour. Bot. **4**, 1929, 291–302, 1 pl. and 22 text-figs.).

**279. The Sex-chromosomes of *Humulus japonicus*.** (Japanese with English résumé). Hitoshi KIHARA. (Japan. Jour. Genetics **4**, 1929, 55–63, 12 figs.).

The sex-chromosomes in *Humulus japonicus* form just as in *Rumex acetosa* a tripartite complex in the reduction division of the pollen mother-cells, consisting of X in the middle and $Y_1$ and $Y_2$ attached to its both ends. The chromosomal formulæ are as follows:

|  | diploid | haploid |
|---|---|---|
| ♂ | $14 + Y_1 + X + Y_2$ | $7 + X$ and $7 + Y_1 + Y_2$ |
| ♀ | $14 + X + Y$ | $7 + X$ |

**280. Ueber die Reizbewegungen der Blumenkronen bei der Gattung *Gentiana*.** (Japanisch mit deutsch. Zfg.). Yoshihiko KISHINAMI. (Bot. Mag. Tôkyô **43**, 1929, 217–227, m. Taf.).

1. Es wurden bei *Gentiana algida* PALL. var. *Igarashii* KUDO., *G. nipponica* MAXIM. und einigen anderen Enzianen die Photo- und Thermonastie der Blumenkronen beobachtet. Da aber bei den genannten Arten, wohl bei allen anderen Enzianen, auch bei den dieselben Reizbarkeiten besitzenden Arten anderer Gattungen von Gentianaceæ, diese beiden Reizbewegungen immer gleichzeitig vorkommen, so können die das Oeffnen und Schliessen auslösenden Temperaturen und Zeitpunkte nicht durch blosse Beobachtungen im Freien, sondern erst durch experimentelle Untersuchungen im Laboratorium genau festgestellt werden.

2. Die Seismonastie der Blumenkronen wurde bei den drei einheimischen Enzianen, *G. nipponica* MAXIM., *G. Thunbergii* GRISEB. var. *minor* MAXIM. und *G. Kawakamii* MAKINO, im Laufe der letzten zwei Jahre zum ersten Male beobachtet. Von diesen drei Arten zeigte *G. Kawakamii* die stärkste Reaktion, die Blüten schlossen sich 30–40 Sekunden vollständig; *G. Thunbergii* var. *minor* dagegen zeigte die schwächste Reaktionen, selbst die empfindlichste Blüte brauchte vier Minuten, um sich vollständig zu schliessen.

Verf.

**281. Bestimmung des "spezifischen Pulvergewichtes" verschiedener ge-
hüllten Reiskörner mittels der "Pulvermethode" und ihre Bedeutung.** (Japa-
nisch). Riichiro KÒKETSU und Hirosi KOSAKA. (Proc. Crop Sc. Soc. Japan **2**, 1928,
7–12).

Mittels der KÔKETSUschen "Pulvermethode" wurden eine Anzahl von Bestim-
mungen ausgeführt, von denen nur einige unten zitiert werden.

1. Das spezifische Pulvergewicht der Reiskörner in verschiedenen Reifestadien
wurde untersucht und es wurde gefunden, dass es allmählich nach dem Forschritt
des Reifens zunimmt.

2. Mittels dieser Bestimmung wurde es festgestellt, dass das spezifische Pulver-
gewicht der Körner kleiner ist, wo sie an den an gutgedüngten als an nicht gedüng-
ten Böden kultivierten Pflanzen angekommen sind.

3. Die Körner an den an salzigen Sumpfboden kultivierten Pflanzen zeigen
grossenteils das kleinere spezifische Pulvergewicht als dieselben, welche an gewöhn-
lichen Sumpfboden angewachsen sind.

**282. Anwendung der "Pulvermethode" für vergleichende Bestimmungen
der Transpirationsgrösse.** (Japanisch mit deutsch. Zfg.) Riichiro KÔKETSU und
Masazô TSURUTA. (Bot. Mag. Tôkyô **43**, 1929, 253–266).

Die bekannte "Pulvermethode" KÔKETSUs wurde für die Bestimmung der
Transpirationsgrösse benutzt. Nach den Verf.n.'s eigenen Worten, "wurden die
Versuche in der Weise ausgeführt, dass die Transpirationsgrösse der normalen und der
zum Welken gebrachten Materialien vergleichend bestimmt wurde, indem die erhal-
tenen Resultate sowohl durch die üblichen Methoden der Angabe als auch durch die
Pulvermethode und zwar durch die Zahl pro Einheit Volumen des Gewebespulvers
der Materialien angegeben wurden, um festzustellan, welche Methode der Angabe
uns rationelle Daten zu erbringen im stande ist." In diesen Versuchen konnten die
Verf.n. von der Zweckmässigkeit der "Pulvermethode sich überzeugen.

**283. On Genera *Tingia* and *Tingiostachya* from the Lower Permian and the
Permo-Triassic Beds in Northern Korea.** Enzo KON'NO. (Japan. Jour. Geol. &
Geogr. **6**, 1929, 113–147, 5 pls.).

*Tingia*, foliage shoot and *Tingiostachya* gen. nov., fertile shoot were found to-
gether in a coal-field of Northern Korea. The author thinks it probable that the
latter represents the reproductive part of the former. On the basis of its morpho-
logical study he reaches the conclusion that the *Tingia* shoots are foliage branches
given off laterally or almost horizontally on the ground, and somewhat obliquely in
reference to their inclined or creeping stem, just as in the recent *Selaginella* or
*Lycopodium.*

In respect to the reproductive part *Tingia* resembles also either *Selaginella* or
*Lycopodium,* inasmuch as its fertile shoot was notably standing vertically on the
ground. But in structure of its reproductive organ (i.e. *Tingiostachya* with its
tetralocular synangia) it differs widely fron these two genera and finds its closest
relative rather in the recent Psilotaceæ, though also widely differing from the latter.

The following species are described: *Tingia Hamaguchii* sp. nov., *T. partita*
HALLE, *T. elegans* sp. n., *T.* cfr. *carbonica* (SCHENK), *Tingiostachya tetralocularis*
nov. sp.

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**284. Beziehung zwischen dem Längenwachstum und der Anthozyanbildung bei *Abutilon avicennae*.** (Japanisch). Hirosi KOSAKA. (Proc. Crop Sc. Soc. Japan 4, 1929, 22–26).

Bezüglich des wachsenden Stengels von *Abutilon avicennæ* hat der Verf. durch eine Reihe von messenden Experimenten die Tatsache festgestellt, dass das Längenwachstum von Stengelteilen und die Produktion des Anthozyanfarbstoffes zueinander im umgekehrter Verhältnisse stehen, d.h. je grösser das Wachstum ist, desto kleiner ist die Menge des dort gebildeten Farbstoffes. Diese enge Beziehung gilt nicht nur örtlich, sondern auch zeitlich.

**285. The Ascigerous Stage of *Helminthosporium sativum*.** (Japanese with English résumé). Kazue KURIBAYASHI. (Trans. Sapporo Nat. Hist. Soc. **10**, 1929, 138–145, 1 pl.).

Isolation experiments of the fungus from the leaves affected by *Helminthosporium sativum* were conducted on rice-culm decoction agar: small sclerotia-like bodies were formed on the small pieces of the host-tissue placed on the medium and these sclerotia developed to perithecia characteristic of the genus *Ophiobolus*. In a single spore culture from the filamentous ascospore of such perithecia the conidia of *H. sativum* were produced, and the infection of barley and wheat by these conidia gave rise to the characteristic lesions of *H. sativum*. The ascigerous stage just mentioned is to be regarded as a new species *Ophiobolus sativus* (P. K. et B.) ITO et KURIBAYASHI. Its description is given.

**286. On the Causal Fungus of the " Bakanae "-disease of Rice-plants, and the Experiments of Its Isolation and Infection.** (Japanese). Eiiti KUROSAWA. (Rpt. Nat. Hist. Soc. Formosa **18**, 1928, 380–401).

By means of certain contrivances the conidia and ascospores of the fungi which were supposed to be the causes of the " Bakanæ "-disease of rice-plants were isolated. Infection experiments were conducted with such spores, not only in the laboratory, but also on the fields, and it was ascertained that of 11 races used in these experiments 10 are the real causes of the disease. According to the author's experiments they are able to infect the rice-grains as well as the plant roots themselves which are entirely woundless. The power of infection is variable according to the temperature and the nutrient media. The fungi produce besides the ascospores two kinds of conidia, large and small. The fungus in question should be properly called *Lisea Fujikuroi* SAW.

**287. On the Cultural Characters of the " Bakanae "-disease Fungi on Various Nutrient Media and the Temperature for Their Development.** (Japanese). Eiiti KUROSAWA. (Rpt. Nat. Hist. Soc. Formosa **19**, 1929, 150–179).

The author has observed the fact that various races of the " Bakanae "-disease fungus, *Lisea Fujikuroi*, when cultivated on different nutrient media, do not display the mode of development and the characters which are common to all of them, whence it is probable that the fungus is distinguishable into a certain number of distinct physiological races.

When they are cultivated on different nutrient media the form as well as the

colour of their colonies are various. To cite a few instances, on bean decoction agar they are circular and rarely coloured, while on hulled rice decoction agar they are membranaceous and right circular and at 30°C coloured pale lobelia violet, etc. etc.

The optimum temperature for their development, as known by determining the diameter of the developing colonies, lies between 25-30°C. At 35°C their development is more or less impeded, and at either 2° and 40° no development at all takes place.

**288. Observations on *Olpidium Trifolii* Schröt.** Shunsuke KUSANO. (Jour. Coll. Agric., Imp. Univ., Tôkyô **10**, 1929, 83–99, 7 figs.).

*Olpidium Trifolii* is the parasite infecting generally the epidermis of *Trifolium repens*, though it was experimentally proven to be able to infect also its subepidermis. The host-cell contains one or more, sometimes more than 20 gametangia. In case when the young host-cell is infected, though it undergoes multiple infection, a few gametangia will be produced on account of the struggle among the fungus individuals. But in case when the host-cell which is older and consequently already feeble in nutritive activity is infected, no such struggle will take place, the result being the production of a large number of small gametangia. Each gametangium is provided with a number of beaks, through which the gametes are liberated out. Each of the latter is pear-shaped and provided with one cilium at its broad posterior end. The copulation of the gametes is as a rule observed in those which are 9 or more days old, the younger ones generally failing to copulate. The fused gametes come at first to rest, and a number of them come to aggregate at a certain spot in the medium. The copulation takes place especially at such a spot. The gametes from one and the same gametangium comes very rarely to copulation, while those from the different ones will actively concern in this process (dioecious!) The copulating gametes are morphologically quite similar, and the sex is hardly distinguishable. The comparative study of the same process in *Olpidium Viciæ* has shown that the gametes from the same gametangium will copulate much more frequently than in *O. Trifolii*. *O. Viciæ* and *Trifolii* are similar in all respects except in the slight difference in the size of gametes and zygotes which are smaller in *Trifolii* than in *Viciæ*. That in spite of this both belong to different species may be seen from the fact that the infection of *Trifolium repens* and *Vicia unijuga* by *O. Viciæ* and *O. Trifolii* respectively is impossible. The gamete copulation gives rise to the planozygote with 4 cilia, which develop to the resting cell, of which the wall is composed of epi-, meso- and endosporium, though the parthenogenetic development of a single gamete is sometimes observed.

**289. Chromosome Arrangement. I. Model Experiments with Floating Magnets and Some Theoretical Considerations on the Problem.** Yoshinari KUWADA. (Mem. Coll. Sci., Kyôto Imp. Univ. Ser. B. **4**, 1929, 199-264, 18 figs.).

Some closer comparisons of various arrangements of chromosomes in the equatorial plates with those of MAYER's floating magnets have been attempted to supplement the results obtained by previous authors. In the present paper the results obtained by the author's collaborators in the meiotic phases of the pollen mother-cells in various plants including a triploid plant are discussed by comparing them with the arrangements of the floating magnets in respect to the following three cases: 1)

Cases where all the chromosomes of one group are nearly of the same size and shape. 2) Cases where some of the chromosomes are different in size and shape from the other chromosomes in the same group, and also where one of the chromosomes is tetrapartite. 3) Cases of hybrids. Several causes of the irregular chromosome arrangements which we meet in fresh as well as in fixed materials are also pointed out.

The resemblance of the chromosomes arrangement to the stable form of floating magnets is marked when the number of chromosomes is relatively small and when the chromosomes present no marked difference in size. When there are size differences, the maximum value of the frequency of occurrence tends to be shifted to another form of arrangement, in which the number of chromosomes occupying the central positions of the arrangement is generally less by one than in the form resembling the stable form of floating magnets. Even in this latter case we can imitate the arrangements to a greater or less extent with floating magnets by varying the numbers of magnetized needles stuck in their floats so as to make them correspond to the sizes of the chromosomes to which they are to be compared. A beautiful example of coincidence between the arrangements of chromosomes and those of the floating magnets prepared in this way was found in the case of *Cycas revoluta*.

Some considerations on the differential organization of chromosomes in connection with their movement towards the poles and on the mechanism of the chromosomes arrangement are given.
Author.

(Cf. Nos. 262, 290, 291, 303, 305, 306, 311, 330.—Ed.).

### 290. On the Structure of the Cytoplasm around the Blepharoplast in *Cycas revoluta*, Thunb. Yoshinari KUWADA and Takeshige MAEDA. (Mem. Coll. Sc., Kyôto Imp. Univ. Ser. B, 4, 1929, 165–174, 2 pls.).

The fact that the blepharoplasts of *Cycas* and *Ginkgo* are provided with conspicuous astral rays is well known. The authors have observed that the latter are present in the fixed specimens but entirely wanting in the living ones. The cytoplasm of the body cell, where they are found are alveolar in structure, and the alveoli are small near them. In the dying body-cell the authors could observe that there appears an alveolar structure in the hyaline area in the immediate vicinity of the blepharoplast. The alveoli are smaller near the latter, and larger the further away from it they are. The walls of the alveoli make an appearance of the ray-figure, continuing from one to the next. The astral rays around the blepharoplasts are to be regarded as artificial structures produced by the fixation of materials.

### 291. Chromosome Arrangement. VII. The Pollen Mother-cells of *Spinacia oleracea*, Mill. and *Vicia faba*, L. Takeshige MAEDA and Kazuo KATÔ. (Mem. Coll. Sc. Kyôto Imp. Univ. Ser. B, 4, 1929, 327–345, 23 figs. and 1 pl.).

In pollen mother-cells of *Spinacia oleracea* the authors could distinguish 4 cases and in *Vicia faba* 6 cases of chromosome arrangement. In both plants the chromosome arrangement resembling that of MAYER's floating magnets is more frequent than the other, i.e. 69.7 and 71.1 % in *Spinacia* and *Vicia* respectively. (Cf. No. 289. —Ed.).

### 292. On New and Noteworthy Plants from the Island of Yakusima I. Genkei MASAMUNE. (Bot. Mag., Tôkyô 43, 1929, 249–252).

A Latin description of some new plants from the Yakusima Island in Southern Japan, viz. *Tropidia nipponica, Liparis yakusimensis, Myrmechis tsukusiana, Ranunculus yakushimensis, R. yaegatakensis* and *Elæagnus yakusimensis*.

**293. Etudes sur la Formation des Grains du Pollen anormaux chez la Pétunie.** (En japonais). Hideo MATSUDA. (Proc. Crop Sc. Soc. Japan **2**, 1928, 50–51).
Chez les fleurs de la Pétunie on voit outre les grains du pollen normaux ceux de la grandeur anormalement considérable. Leur mode de développement n'est pas toujours le même. Dans un certain cas, pendant la phase d'intercinèse de la mitose réductionelle un grand noyau est produit au lieu de deux noyaux-fils, qui contient au moins 14 chromosomes, ou même plus. Ce noyau ne subit aucune division et conséquemment il donne naissance à une grande monade tétraploïde. Dans un autre cas le grand noyau subit une division et deux dyades diploïdes sont formées. Encore quelquefois les groupes des chromosomes-filles produites par la division viennent à se fusionner entre elles, produisant ainsi les grains tétraploïdes ou triploïdes.

**294. Ueber die Wassergehaltsveränderung der sich entwickelnden Reiskörner und die Beziehung zwischen ihre Entwicklung und Reifestadien.** (Japanisch). Kiyokatsu MATSUDA. (Proc. Crop Sc. Soc. Japan **3**, 1929, 58–65, m. 2 Kurven).
Nach den Resultaten der Verf. s experimentellen Studien wird die Länge der sich entwickelnden Reiskörner während der Milchreife vollendet, während ihre Breite und Dicke erst beim Eintritt der Gelbreife zur Vollendung kommen. Die Zunahme des Frischgewichtes der Körner wird nach dem Eintritt des Gelbreifestadium noch während einiger Zeit fortgesetzt, und dieselbe des Trockengewichtes dauert noch länger. Der Wassergehalt erreicht sein Maximum bei der Milchreife und nimmt allmählich während der Gelbreife bis zur Vollreife ab. Nach der Verf.s Rechnung beträgt das prozentige Verhältnis des Wassergehaltes der Körner gegen ihr Frischgewicht 86% zur Zeit des Blühens und nur 19% am 49.–51. Tage nach demselben. Die ganze Verhältnisse sind durch zwei Kurven dargestellt.

**295. On the Development of Rice-kernels.** Kiyokatsu MATSUDA. (Jour. Sc. Agric. Soc. Japan No. **314**, 1929, 1–35, 6 figs.).
The growth of rice-kernels during their development was studied. The change of size in three dimensions, dry and wet weight, water-content, ash contents during their development was minutely traced out, and the results are given in detail in the tables and curves. (Cf. No. 294.—Ed.).

**296. Oekologische Studien vom Mizoro-Teiche.** (Japanisch). Shigeru MIKI. (Mitteil. aus Ges. f.d. Studien der geschichtl. Denkmäler in Kyôtohu **10**, 1929, 145, 10 Lichtdrucktaf., 44 Textabb.).
Der Mizoroteich in Kyôto beträgt von West nach Ost und von Nord nach Süd 450 m. bzw. 275 m. in der Länge, etwa 2 km im Umfang und mehr als 8 Hekt. in der Fläche. Es ist ein Becken mit Torfboden. Der Verf. hat sehr ausführlich die pH-Veränderung des Teichwassers nach den Stunden und der Saison bestimmt, wonach es immer sauer reagiert. Auch sein O- und $CO_2$-Gehalt ist stark veränderlich und vom Verf. genau bestimmt. Alle Resultate der obigen Bestimmungen sind in vielen

ausführlichen Tabellen geschildert, wonach das Maximum sowohl des O-Gehaltes als des pH-Wertes zu 2.–4. Uhr Nachmittags und dasselbe des $CO_2$-Gehaltes zu 4.–6. Uhr Vormittags zu beobachten ist.

Dieser Teich ist durch das Vorkommen darin vieler Schwimminseln ausgezeichnet. Sie bestehen aus von den Wurzelstöcken und Faserwurzeln von *Nuphar subinteger-rimum* und *Brasenia peltata* dicht durchsetzten Bodenmasse. Das Aufschwimmen in derselben ist durch die Ansammlung der dort entwickelten Gasen ermöglicht. Im Teichwasser wachsen *Brasenia peltata*, *Nuphar subintegerrimum*, *Nymphœa tetra-gona*, *Potamogeton Fryeri* usw. Am Rande des Teiches wachsen *Menyanthes trifoliata*, *Hieracium Krameri* usw. Auf den Schwimminseln wachsen *Iris albopurpurea*, *Pogo-nia japonica*, *Sagittaria Ag.nashi*, *Rhynchospora Franchetiana*. Besonders merk-würdig ist das Vorkommen darin zahlreicher *Sphagnum*polster, wo eine grosse An-zahl von Insektivoren anzutreffen sind.

Diese Abhandlung enthält noch viele interessante Einzelheiten, wofür an das Original verwiesen sei.

### 297. On the Occurrence of a Certain Behring and Kurile Species of Lami-nariaceae in a Small Isolated Region off the Southern Extremity of Saghalien. Kingo MIYABE. (Proc. Third Pan-Pac. Sc. Congr. Tôkyô 1926 Vol. **1**, 1928, 954–958).

Off the extreme southern end of Saghalien, about the Perouse or Soya Strait there is a certain region extending from Cape Notoro northwards on the west coast for a distance of about twenty miles. The surface temperature near the coast of this region is said to be from 6° to 8°C even in August. In this region the author could find unexpectedly certain Behring or Kurile species, affording an evidence of the limiting action of the temperature of the sea-water on the distribution of marine algæ. The algal species above mentioned are for instance *Arthrothamnus kurilensis*, *Laminaria dentigera*, *L. longipedalis*, *L. cichorioides* var. *sachalinensis*, *Kjellma-niella crassifolia*, *Alaria fistulosa*, *A. dolichorachis*, *A. lanceolata*, *A. ochotensis*, and *Costaria Turneri*.

### 298. On the Sexual Generation of Japanese Laminariaceae. Kiichi MIYAKE. (Proc. Third Pan-Pac. Congr. Tôkyô 1926, Vol. **1**, 1928, 1922–23).

The artificial culture of 9 species of the Japanese Laminariaceæ, incl. the genera *Kjellmaniella*, *Alaria*, *Ecklonia*, *Eisenia*, *Undaria*, *Chordaria* and *Laminaria* was done. The author could observe the germination of zoospores, the production of gametophytes with sexual organs as well as that of young sporophytes.

### 299. On the Inheritance of the Length and Width of Leaves in Barley. (Japanese with English résumé). Bungo MIYAZAWA. (Bull. Miyazaki Coll. Agric. & Forest. **1**, 1929, 1–14, 1 fig.).

The inheritance mode of leaf length and width was studied on several Japanese varieties of barley by the method of crossing. Long leaf is generally dominant over short one, while the width of hybrids is intermediate between that of the two parents.

As to the length the author got in $F_2$ the bimodal curve, and through the method of curve analysis he reached the conclusion that the two parents differ in their respec-tive leaf length by one factor. This conclusion was confirmed by the $F_3$ culture.

The leaf width was found to segregate in $F_2$ into the 1:2:1 ratio.

**300. Studies on the Botanical Name of Japanese Iris and Its Horticultural History.** (Japanese with English résumé). Bungo MIYAZAWA. (Bull. Miyazaki Coll. Agric. & Forest. **1**, 1929, 15–41, 2 figs.).

The Japanese Iris is generally known by the scientific name *Iris lævigata* FISCH. or *I. Kœmpferi* SIEB. The author's study of the herbarium specimen collected by THUNBERG and deposited in the Uppsala University has convinced him that it must be rightly called *I. ensata*, while what is generally called by the latter name is really *I. biglumis* VAHL.

The culture of the Japanese *Iris* began in Japan 473 years ago, and its garden varieties began to appear since 1907. We may count at present more than six hundred garden varieties through the author's selection work in recent years.

**301. Interspecific Hybridization in *Brassica* II. The Cytology of F₁ Hybrids of *B. cernua* and Various Other Species with 10 Chromosomes.** Toshitaro MORINAGA. (Japan. Jour. Bot. **4**, 1929, 277–289, 3 pls.).

**302. Interspecific Hybridization in *Brassica* III. The Cytology of F₁ Hybrids of *B. cernua* and *B. Napella*.** Toshitaro MORINAGA. (Jour. Dpt. Agric., Kyushu Imp. Univ. **2**, 1929, 201–206, 2 pls.).

The crossing between *Brassica Napella* and *B. cernua* with 19 and 18 chromosomes respectively was done. In the heterotypic meiosis of the pollen mother-cells of the F₁ hybrids 10 gemini situated in the equatorial region as well as 17 univalents scattered outside the spindle were observed. The fact was thus established that the synaptic union takes place between 10 pairs of chromosomes from both parents having the strong affinity to each other, and never between the remaining ones. The homotypic meiosis is quite regular, the laggards being very rarely found.

**303. Chromosome Arrangement. II. The Meiotic Divisions in Pollen Mother-cells of *Phaseolus chrysanthos* Sav. and *Cassia occidentalis* L.** Aitaro MUTO. (Mem. Coll. Sc., Kyôto Imp. Univ. Ser. B, **4**. 1929, 265–271, 3 figs.).

The haploid number of chromosomes in pollen mother-cells in some cultivated forms of *Phaseolus chrysanthos* and *Cassia occidentalis* is 11 and 13 respectively. In the former cases where the number of chromosomes found inside the ring is the same as that of the inside floating magnets are most frequent when all chromosomes are arranged in the equatorial plane (=63.2%), while those where some are scattered slightly above or below that place is less numerous (= 52.6 %). In *Cassia* these frequencies are 58.8 and 56.6% respectively. In both genera the most frequent form of chromosome arrangement is similar to the stable form of the arrangement of floating magnets, thus for example in *Phaseolus* those forms in which 3 chromosomes are arranged in the form of a regular triangle, surrounded by a circular ring of chromosomes are most frequent. (Cf. No. 289.—Ed.).

**304. Karyological Studies of the *Narcissus* Plant I. Somatic Chromosome Numbers of Some Garden Varieties and Some Meiotic Phases of a Triploid Variety.** Seijin NAGAO. (Mem. Coll. Sc., Kyôto Imp. Univ. Ser. B, **4**, 1929, 175–198, 39 figs.).

The author has examined the root-tip cells of some garden varieties of *Narcissus*, and found there the di-, tri-, tetra-, and hexaploid number of chromosomes, besides the heteroploid one, 7 being the basic number. In the triploid variety 7 trivalent chromosomes are seen. In the nuclear division the two triplets of each trivalent chromosome are separated out regularly to the poles, while the third one undergoes a random distribution with any one of the two other triplets. Sometimes it lags behind the other, and undergoes a longitudinal split. The result is the difference in chromosome number and combinations at the poles. The homotype division in the pollen mother cells was observed. Besides regular tetrads diads or triads may be produced.

**305. Chromosome Arrangement. VIII. The Heterotype Division of Pollen Mother-cells in a Triploid Variety of the *Narcissus* Plant.** Seijin NAGAO. (Mem. Coll. Sc., Kyôto Imp. Univ. Ser. B, **4**, 1929, 347–352, 17 figs.).

The author has observed that in half of the cases studied uni- and bivalent chromosomes occupy the outer positions, forming a ring with the trivalents or are left outside the chromosome ring. The meaning of this phenomenon is yet unknown. (Cf. No. 289.—Ed.).

**306. Chromosome Arrangement. IX. The Pollen Mother-cells in *Cycas revoluta*, Thunb.** Takeshi NAKAMURA. (Mem. Coll. Sc., Kyôto Imp. Univ. Ser. B, **4**, 1929, 353–369, 16 figs.).

In the heterotype division of pollen mother-cells of *Cycas revoluta* the number of chromosome gemini is 11 generally and 12 in very few cases. In both cases the author could distinguish a pair of large chromosomes ($L_1$ and $L_2$). In the endosperm it is 12 and in the nucellus 24.

The chromosome arrangement was studied in pollen mother-cells having 11 elements. The form of arrangement (having 3 inner chromosomes) does not present the first maximum of frequency, but the second, the first being represented by the form having 2 inner chromosomes. The two large elements $L_1$ and $L_2$ occupy the central position. (Cf. No. 289.—Ed.).

**307. Preliminary Notes on Yellow Spot Disease of Wheat Caused by *Helminthosporium Tritici-vulgaris* Nisikado.** Yosikazu NISIKADO. (Ber. Ôhara Inst. landw. Forsch. **4**, 1929, 103–109, 2 pls.).

An English translation of the paper formerly published in Japanese. (Cf. Japan. Jour. Bot. **4**, 1929, (68), No. 206).

**308. Studies on the *Helminthosporium* Disease of Gramineae in Japan.** Yosikazu NISIKADO. (Ber. ÔHARA Inst. land. Forsch. **4**, 1929, 111–126, 9 pls.).

An English résumé of the content of the work formerly published in Japanese. (Cf. Japan. Jour. Bot. **4**, 1929, (69), No. 207).

**309. Preliminary Note on the Studies of Black-spot Disease on *Ulmus*.** (Japanese). Yosikazu NISIKADO and Hiroyosi MATSUMOTO. (Agric. & Hort. **4**, 1929, 655–662, 8 figs.).

A disease on some species of *Ulmus*, as *parviflora*, *japonica*, and *pumila* which

is prevalent not only in Japan, but also in Manchuria and China, becomes recognizable soon after the development of leaves in early spring and is continued during the existence of green leaves. The spots on leaves which are at first yellowish become gradually larger, and produce black stroma-like bodies in their central part; leaves which are severely diseased fall down. The causal organism was for a long time erroneously taken for *Melasmia ulmicifolia* B. et C. or *Systremma Ulmi* (SCHLEICH.) THEISS. et SYDOW. The critical examination has led the authors to the conclusion that though it is allied to *Gnomonia ulmea* (SCHW.) THUEM. it differs from it and is a new species which the authors call *Gnomonia Oharana* NISIKADO et MATSUMOTO.

**310. Studien über den Einfluss der Aussenbedingungen auf das Aufblühen der Reispflanzen.** Yakichi NOGUCHI. (Japan. Jour. Bot. 4, 1929, 237-276, 2 Textabb.).

**311. Chromosome Arrangement. V. Pollen Mother-cells in *Torilis Anthriscus*, Berh. and *Peucedanum japonicum*, Thunb.** Kinya OGAWA. (Mem. Coll. Sc., Kyôto Imp. Univ. Ser. B., 4, 1929, 309-322, 6 figs. and 1 pl.).

Both 8 and 11 may be regarded as the basic chromosome numbers in the Umbelliferæ. In *Torilis Anthriscus* and *Peucedanum japonicum* the arrangement of the chromosomes resembles generally that of MAYER's floating magnets. In the case of homotype division of *Peucedanum* the resemblance is however less remarkable. (Cf. No. 289.—Ed.).

**312. On the Systematic Importance of the Spodograms of the Leaves of the Bambusaceae VI.** Kiichi OHKI. (Bot. Mag. Tôkyô 43, 1929, 193-205, 6 fig.).

Continuation of the author's former studies, incl. *Pleioblastus yamakitensis*, *P. Simoni*, *P. Chino*, *P. communis*, *P. oikawensis*, and *P. niitakayamensis*.

**313. Contribution à l'Étude des Effects de l'Incision annulaire sur la Vitesse de Maturation.** (En japonais avec le sommaire en français). Yasusi OINOUE. (Bull. Inst. OINOUE de Recherches agronom. et biol. 2, 1928, 1-8).

L'incision annulaire des rameaux fructifères chez le *Vitis labrusca*, *vinifera* et leurs hybrides conduit à hâter la vitesse de la véraison et de la maturation. L'accélération est plus grande dans les variétés tardives que dans les variétés précoces. L'effet de l'incision susdite ist dû à l'augmentation de leur teneur en sucre par ce procédé.

**314. Sur l'Accumulation des Hydrates de Carbone facilement hydrolisables dans l'Intérieur des Corps de la Vigne et du Pêcher et leur Maturation.** (En japonais avec le sommaire français). Yasusi OINOUE. (Bull. Inst. OINOUE de Recherches agronom. et biol. 2, 1928, 8-20).

En vertu de l'incision annulaire pratiquée chaque année sur les rameaux de la vigne de semis, par exemple, l'auteur a trouvé qu'ils commencent à fructifier après $3,92 \pm 0,103$ ans de semis, tandis que les témoins en ont dû $5,04 \pm 0,123$ ans. En vertu de l'injection du sucre (20% de glucose) dans le corps de la vigne il a trouvé qu'elle arrive à la maturité sexuelle plus tôt que le témoin. L'auteur a conséquemment

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arrivé à la conclusion que la maturation sexuelle de la vigne et d'autres plantes par l'incision soit due au moins partiellement à l'accumulation des hydrates de carbone facilement hydrolisables dans leur corps.

**315. Recherches sur le Phénomènes du Désordre des Epoques du Cycle végétatif de la Vigne par l'Absorption à l'Excès de certain Elément nutritif et le Partage des Eléments absorbés qui modifie l'Intensité de la Formation d'un Tissu homogène.** (En japonais avec le sommaire français). Yasusi OINOUE. (Bull. Inst. OINOUE de Recherches agronom. et biol. **2**, 1928, 21–49).

L'objet principal de cet article consiste à nier l'exactitude de la loi de minimum concernant la nutrition des végétaux. L'auteur en a fait les considérations mathématiques et un certain nombre des expériences sur la vigne, où l'on a ajouté la potasse, le phosphate ou l'azote en excès. Il considère que si un élément nutritif en quantité minimum fait la plante strictement refuser l'absorption de la quantité au-dessus de minimum des autres éléments, la variation physiologique et morphologique ne serait jamais causé par les engrais de différentes compositions. Voici quelques résultats de ses expériences. L'engrais azoté employé à très haute dose un peu avant la véraison suspend la maturation des raisins et augmente la vitesse de la division cellulaire aux points végétatifs, tandis que l'emploi d'engrais potassique à très haute dose accélère la maturation, mais diminue la vitesse de la croissancs végétative, etc. etc.

**316. Study of _Euryale ferox_ Salisb. III. On the Form and Structure of Juvenile Leaves.** Yônosuke OKADA. (S. Rpts. Tôhoku Imp. Univ. 4th Ser. (Biol.) **4**, 1929, 117–126, 2 pls. and text-figs.).

The juvenile leaves of _Euryale ferox_ from Zyûnityôgata appear in the following order: 1. subulate, submerged, 2. narrow hastate, submerged, 3. broad hastate, submerged, and 4. fissi-cordate, floating, though in the plants from the other localities the third leaf may be the floating one. The length of the petiole (or the total length of the leaf in 1, where no differentiation of lamina and petiole is present) is variable according to the depth of water, but it may be stated that the range of variation in 1, 2 and 3 is very small, while in 4 it is very large. In 1 epidermal cells are long and run parallel to the leaf axis, but from 2–4 they become gradually isodiametrical and small, and in 4 the sinuous appearance of the epidermis is in general a quite pronounced characteristics. Stomata are present only in the upper surface; they are absent in 1, very rarely present in 2, somewhat oftener in 3, and abundant in 4.

Besides the upper surface of 4 is more coriaceous than in others, possesses much differentiated palisade tissue; its petiole is much more resistant against traction than the others.

**317. Note on the Germination of the Spores of Some Pteridophytes with Special Reference to Their Viability.** Yônosuke OKADA. (Sc. Rpts. Tôhoku Imp. Univ. 4th Ser. (Biol.) **4**, 1929, 127–182).

The experiments were performed on the spores of _Equisetum arvense_, _Osmunda japonica_, _O. cinnamomea_, _Dryopteris viridescens_, _Woodwardia orientalis_, and _Matteucia Struthiopteris_. The culture was generally on 0,1% KNOP solution, the same added with 1% agar, and distilled water. In pure water the spores of all

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species were unable to germinate except those of *Osmunda* which showed even then some rate of germination. The optimum temperature lies for all at about 25°, maximum at a little higher than 40°, and minimum at ±10°. As to the effect of illumination neither the maximum nor the optimum could not be determined, except in *Equisetum* where the optimum lies at ±625 mc. Under very weak light the spores are in general able to germinate. Direct sun rays are fatal, while diffuse light is favourable. Spores are unable to germinate in complete darkness, though *Equisetum* and *Osmunda* were capable to germinate under this condition at 25°. The anærobic condition prevents entirely the germination of the species preserved in the laboratory, those of *Equisetum arvense* become incapable of germination after 10–24 days, while those of *Woodwardia* may survive 174–191 days; the spores of others lie between these two extremes. The storage of spores in a dark and cold place are more favourable for keeping the viability. The water content is various in spores, and *Equisetum* spores which are richest in water are, as above stated, distinguished for short viability. The *Equisetum* spores are also distinguished by showing the decided sign of respiration.

**318. A New Species of *Ilex* in Yamato Province.** Yûzi OKAMOTO. (With Japanese résumé). (Bot. Mag. Tôkyô **43**, 1929, 71–73 with figs.).

An illustrated Latin description of a new species *Ilex ellipsoidea*.

**319. On the Distribution of Marine Algae in Japan.** Kintaro OKAMURA. (Proc. Third Pan-Pac. Sc. Congr. Tôkyô 1926, Vol. **1**, 1928, 958–963, 1 fig.).

First of all the course of warm Japan current (Kurosiwo) and that of cold Kurile current in the vicinity of Japan and Korea are described.

In Japan there are three distinct algal floras, viz. subarctic, temperate and subtropical, and the author distinguishes five regions in the Pacific coast for algal distribution. In the first region, which is subarctic and extends from Syumusiru Island to Kinkwazan the Ochotsk flora is predominating, such as *Thalassiophyllum*, *Constantinea*, *Arthrothamnus*, *Odonthalia*, etc. The second region which is rich in temperate flora, extends from Kinkwazan to Hyûga-Ôsima on the eastern coast of Kyûsyû; *Undaria*, *Acanthopeltis*, *Hyalosiphonia*, etc. are abundant. In the third region which includes the southern part of Kyûsyû from Hyûga-Ôsima to the Cape Noma on the western coast of the province Satuma, and also Ryûkyû, Formosa and Bonin, the only indigenous alga is *Halicoryne Wrightii*, the others being those which are common to the forms from Australian Red Rea, Indian Ocean, etc. The fourth region which extends from the Cape Noma to the Tugaru Strait along the coast of Japan Sea has the floral aspect quite similar to the third region. The fifth region, extending from the Tugaru Strait to Nemuro through the Soya Strait has the temperate feature, and may be considered as the continuation of the fourth region with some Ochotsk species.

**320. Effects of Grazing of the Vegetation of Native Pasture.** (Japanese with English résumé). Motoo OOSEKO. (Jour. Sc. Agric. Soc. **316**, 1929, 93–105).

Experiments were made during four successive years to ascertain the effect of horse grazing on the vegetation of native herbaceous pastures. The native vegetation of herbaceous pastures in Japan may be classified into three types, viz. *Miscan-*

*thus* Consociation (*Miscanthus sinensis,* etc), *Imperata* Consociation (*Imperata arun-dinacea,* etc), and *Zoysia* Consociation (*Zoysia pungens* var. *japonica,* etc) according to their successional stages.

The study of the plant succession was carried out on the protected (no grazing), the moderately grazed and the overgrazed area by various means. It was thus ascertained that firstly naturally in the course of years the density of plant cover becomes much smaller in the two latter areas than in the former (the ratio of density in the three areas=1.00:0.63:0.40), and secondly the grazing results in complete destruction of subclimax plant cover and causes the retrogressive succession, while the nongrazing leads to the promotion of the plant cover development as well as to the progressive succession.

**321. Proceedings of the Third Pan-Pacific Science Congress, Tokyo 1926.** Ed. Nation. Res. Council Japan 1928. 2 vols., 2678 pp.

The following articles contained in this book are more or less of botanical interest. Many of them were already published elsewhere, and not infrequently more in detail than in this book. For abstracts of some of these papers s. Nos. 297, 298, 319.

BROWN, W. H.: Philippine vegetation

CAMBAGE, R. H.: Notes on the development of some Australian plants

CAMPBELL, D. H.: The Australasian element in the Hawaian flora

GUILLAUMIN, A.: Les régions floristiques du Pacifique d'après leur endémisme et la répartition de quelques plantes phanérogames

HAYATA, B.: Succession in the vegetation of Mt. Fuji and the formulation of a new theory, the succession theory in opposition to the natural selection theory

HAYATA, B.: The succession and participation theories and their bearings upon the objects of the Third Pan-Pacific Science Congress

HAYATA, B.: The relation between the succession and participation theories and their bearings upon the natural system

HEMMI, T.: An outline of experimental studies on the "indefinite" disease of the rice plant

HU, H. H.: A preliminary survey of the forest flora of Southeastern China

ISHIYAMA, S.: Bacterial leaf-blight of the rice-plant

KAWAMURA, S.: On the periodical flowering of the bamboo

KOMAROV, L.: On the arctic limits of some trees of the Russian Far East

KORIBA, K.: Observations on a Japanese species of *Tæniophyllum*

KORIBA, K. & TASHIRO, Z.: On the vegetation of Sakurajima after the eruption of 1914

MAEKAWA, T.: Preliminary report on the influence of cotyledons on the root regeneration of young plants

MERRILL, E. D.: Some Polynesian botanical problems of fundamental importance

MIYABE, K.: On the occurrence of a certain Behring and Kurile species of Laminariaceæ in a small isolated region off the southern extremity of Saghalien (S. No. 297)

MIYAKE, K.: On the sexual generation of Japanese Laminariaceæ (S. No. 298)

MIYOSHI, M.: Preservation of botanical natural monuments in Japan

NAGAI, K. & TANIKAWA, T.: On *Citrus* pollination

NAKAI, T.: The floras of Tsusima and Quelpært as related to those of Japan and Korea

NAKAI, T.: The vegetation of Dagelet Island

NAKANO, H.: On the remarkable powers of water absorption by the leaves of *Polypodium lineare* Th., with especial reference to the ecology of this plant

NISIKADO, Y.: Comparative studies on the *Helminthosporium* disease of rice in the Pacific regions

OKAMURA, K.: On the distribution of marine algæ in Japan (S. No. 319)

OSBORN, T. G. B.: On regeneration problems in arid Australia

PORTER, R. H.: Some aspects of plant pathology in China

SETCHELL, W. A.: Migration and endemism with reference to Pacific insular floras

SKOTTSBERG, C.: Remarks on the relative independency of Pacific Floras

SWINGLE, W. T.: The origin of the flora of Eastern Asia, a reservoir of useful plants

SWINGLE, W. T.: "Kindzu" or "Golden Bean" orange (*Fortunella Hindsii*) from historic, taxonomic and cytologic standpoints

SWINGLE, W. T.: A study of the phylogenetic relationships of the rutaceous subfamily Citratæ, including the *Citrus* fruits and their wild relatives, with experimental studies in the hybridizing and grafting plants of this subfamily

SWINGLE, W. T.: Meta-zenia or the influence of the male parent on the tissues of the mother-plant outside of the embryo and endosperm, especially exemplified in the date palm

TAKENOUCHI, M.: On the influence of volcanic activity upon the vegetation of Mt. Tarumai

TANAKA, T.: Discussion of the pomology of the most important Pacific races of *Citrus* fruits

TERAO, H.: Occurrence of mutation in the rice plant

TERAZAKI, W.: Plant successions in self-regenerating forests in various regions of Japan

TILDEN, J. E.: The distribution of marine algæ, with special reference to the flora of the Pacific Ocean

WAI, N.: Two new kinds of mould putrefying wooden houses in the Orient

WENT, F. A. F. C.: The Pacific Ocean as a boundary of the distribution of the Podostemonaceæ

YAMADA, Y.: The phytogeographical relation between the Chlorophyceæ of the Mariannes, Carolines and Marshall Islands and those of the Malay Archipelago, Australasia and Japan.

**322. On the Seed-bearing Leaves of *Ginkgo*.** Mitidi SAKISAKA. (Japan. Jour. Bot. 4, 1929, 219–235, 3 pls. and 10 Textfigs.).

**323. On the Number of Chloroplasts in the Guard-cells of Seed-plants.** (Japanese). Mitidi SAKISAKA. (Bot. Mag. Tôkyô 43, 1929. 46–48).

Concerning various plants, such as *Canna, Musa, Commelina, Tradescantia, Pharbitis, Dioscorea, Vicia* and *Dahlia* the number of chloroplasts in the guard-cells

of leaves was calculated in June and July. It was found that it amounts on the average to 4-22 for one guard-cell, minimum 3 and maximum 24.

### 324. Notes on the Development of the Star-hairs of *Elaeagnus*. (Japanese). Mitidi SAKISAKA and Yasuo SUEHIRO. (Bot. Mag. Tôkyô **43**, 1929, 117–121, 13 figs.).

The observations refer to some Japanese *Elœagnus* species. In each the authors could distinguish two distinct types of star-hairs, viz. large (maximum diameter 0.5 mm) and small (minimum diameter 0.2 mm), covering leaves, twigs, sepals and fruits. The larger types in the species studied are so different in form in each, that they may be well used for distinguishing them, while the small ones are of no use for this purpose. Their development was traced. These hairs may serve for protection against transpiration.

### 325. A Phomopsis Disease of Soy-bean. (Japanese). Seizaburô SASAKI. (Ann. Agric. Exp. Sta. Gov. Gen. Chosen **4**, 1929, 1–28, 2 pls.).

The phomopsis disease of soy-bean is widely distributed in all parts of Korea. Though it does cause no total disease of host plants, it makes their legumes quite uneatable. The causal fungus belongs to the genus *Phomopsis*, and seems to be identical with imperfect generation of *Diaporthe sojœ* discovered by LEHMAN in 1923. It grows well on various nutrient media. Its mycelium grows most rapidly in 10% glucose or saccharose solution; the optimum temperature for its growth is 25°C. The fungus may survive very long on nutrient media, for example more than 652 days.

### 326. On the Distribution of the Prototypes of Rice-plants. (Japanese). Takashi SASAKI. (Proc. Crop. Sc. Soc. Japan **3**, 1929, 7–19, 4 figs.).

The following conclusion made by the author concerning the distribution of the prototypes of rice-plants is founded on the comparative studies of the herbarium specimens in various European museums.

The distribution of the prototypes of the rice-plant is very extensive. They extend from Southern Asia, including India, Malay Peninsula, Siam, Cochinchina, Borneo, etc. to Northern Australia, and further to West Indies, Central America and South America, including Brazil and Paraguay.

### 327. Systematic Importance of Spodograms of Leaves in the Urticaceae I. (Japanese). Yosisuke SATAKE. (Bot. Mag. Tôkyô **43**, 1929, 206–217, 10 figs.).

The spodograms of leaves of the Urticaceæ are studied for the purpose of classification and identification. The characters used for this purpose are the cystoliths, crystals of calcium oxalate, silicate bodies and carbonate and silicate skeletons, etc. which vary in their presence or absence, quantity, distribution, etc. *Ulmus japonica*, *U. laciniata*, *U. Sieboldii*, *Aphananthes aspera*, *Zelkowa serrata*, *Celtis sinensis* var. *japonica*, *Trema orientalis*, *T. amboinensis* are the objects of the present study.

### 328. Materials for the Study of Formosan Fungi (27). (Japanese). Kaneyoshi SAWADA. (Rpt. Nat. Hist. Soc. Formosa **19**, 1929, 31–38).

Description of the following Myxomycete and fungi, viz. *Phytoceratiomyxa* nov. gen., *P. Osmundœ* nov. sp., *Kordyana Aneilemœ* nov. sp., *Exobasidium Gaultheriæ*

nov. sp., *Ithyphallus rugulosus* Fisch., *I. roseus* nov. sp., *Xylaria polymorpha* (Pers.) Grv. and *Uleomyces decipiens* Syd.

**329. Onion Rust Fungus, *Puccinia Porri* in Japan.** (Japanese). Kaneyoshi Sawada. (Rpt. Nat. Hist. Soc. Formosa **19**, 1929, 180-185.

The author has formerly published the fact that the red rust fungus of onions in Formosa as well as Japan proper belongs to *Puccinia Allii* (DC) Rud. In this paper he announces the discovery of another rust fungus, *Puccinia Porri* on the onions cultivated in Morioka (in Northern Japan), of which he could observe only the winter- and summer-spores. The æcidial stage was entirely wanting. (Cf. Japan. Jour. Bot. **4**, 1929, (71), No. 218.—Ed.).

**330. Chromosome Arrangement. IV. The Meiotic Divisions in Pollen Mother-cells of *Sagittaria Aginashi* Makino and *Lythrum Salicaria*, L. var *vulgare*, DC., subvar. *genuina*, Koehne.** Namio Shinke. (Mem. Coll. Sc., Kyoto Imp. Univ. Ser. B, **4**, 1929, 283-308, 9 figs.).

In pollen mother-cells of *Sagittaria Aginashi* the number of double chromosomes in the heterotype metaphasis is 11, of which one large (M-chromosome) and one small (a-chromosome) are distinguishable from the remaining 9. The cases where the chromosome arrangement resembles the most stable form of floating magnets is 53.8% in their frequency. The a-chromosome takes the central position more, and the M-one less frequently than we might expect from the probability.

In the heterotype metaphasis of the pollen mother-cells of *Lythrum* some sort shows 15, and some other 14 chromosomes. The form of chromosome arrangement resembles most frequently that of the floating magnets. But there is a second maximum of frequency. The latter is found in the case of 15 and 14 chromosomal elements in that arrangement which affords the first maximum in the case of 14 and 15 elements respectively. A tetrapartite chromosome, when present, is found usually in the peripheral position. (Ci. No. 289.—Ed.).

**331. Histological Studies on the Seed-coats of Rice.** (Japanese). Tunetosi Sibuya. (Proc. Crop Sc. Soc. Japan **2**, 1928, 15-16).

The development of the outer and inner integuments of ovules of rice and their histological differentiation is shortly described. The seed-coat of rice is derived from the inner integument of ovule exclusively, nucellar cells taking no part.

**332. On Some Marine Diatoms from Siberian Shore of Japanese Sea.** B. W. Skvortzow. (Bot. Mag. Tôkyô **43**, 1929, 57-59, with figs.).

The enumeration and description of marine diatoms collected on *Laminaria* species and also got at Harbin in the Chinese markets are given, among which there are two new species, *Navicula Ikarii* and *Gomphonema Okamurai* as well as some new varieties.

**333. Ueber die Keimungsversuche des Pollens der Gramineen.** (Japanisch). Kiyomitsu Tabata, Riiti Kikuti und Zin'ei Sasaki. (Proc. Crop Sc. Soc. Japan **4**, 1929, 64-76, 1 fig.).

Die Versuche wurden an einer Anzahl von Gramineen ausgeführt, welche zu den Gattungen *Hordeum, Triticum, Oryza, Avena, Secale, Zea, Setaria, Andropogon, Panicum, Coix* und *Euchlæna* gehören. Unten sei einige Resultate dieser Versuche kurz erwähnt werden. Nach den Verf.n. ist für die Keimung des Gramineenpollens die Zuckerlösung mit etwas Agar das beste Mittel zu betrachten, und zwar zu 15–45 % im allgemeinen. Mittels der Hinzufügung dazu des Narbensekretes konnten die Verf.n. im allgemeinen sowohl die Beschleunigung der Keimung als die Zunahme des Pollenschlauchwachstums nachweisen. Die Zahl der keimenden Pollenkörner ist bei den Gramineen immer klein. Die Länge des Pollenschlauches ist kurz; sein Längenwachstum ist ungefähr 2 Stunden nach des Pollensäens am grössten und wird bis zur 5. Stunde fortgesetzt. Nach 24 Stunden bleibt es ganz aus.

**334. Rhizoid Formation in the Embryo of *Turbinaria* (?) *fusiformis* Yendo and *Sargassum Thunbergii* O. Kuntze.** Masato TAHARA. (Sc. Rpt. Tôhoku Imp. Univ. 4th Ser. (Biol.) **4**, 1927, 1-5, 4 figs.).

In *Turbinaria* (?) *fusiformis* YENDO the first segmentation wall of the egg runs perpendicular to the long axis of the embryo. The second one cuts off a lens-shaped rhizoid initial cell. The latter changes into a quadrant owing to the two division walls perpendicular to each other. Each quadrant cell is then divided by the third segmentation wall which is parallel, oblique or radial to the two first segmentation walls, and consequently from each quadrant eight cells are produced. Each of the latter develops into a rhizoid, so that at one extremity of the embryo a group of eight rhizoids is observed.

In *Sargassum Thunbergii* O. KUNTZE which was at first placed under *Turbinaria* by YENDO, the mode of rhizoid formation is really the same as in *T. fusiformis*, except the fact that the third segmentation wall mostly runs oblique, not radial. On account of this accordance of the mode of rhizoid formation the author thinks it preferable to place *S. Thunbergii* under the same genus as *Turbinaria fusiformis*.

**335. Bibliographie von *Aspergillus*.** Hiroshi TAMIYA und Shinkichi MORITA. (Bot. Mag. Tôkyô **43**, 1929, 60-71, 145-156, 179-189, 237-249, 281-291).

Eine vollständige und dankenswerte Zusammenstellung der von 1729 bis zu 1928 erschienenen Literatur über *Aspergillus* der ganzen Welt. Wird weiter fortgesetzt werden.

**336. On the Origin of the Genus *Citrus*.** (Japanese with English résumé). Tyôzaburo TANAKA. (Studia Citrologia **2**, 1928, 19-32).

The comparative studies of morphological characters in various forms of the subfamily Citratæ in the Rutaceæ has led the author to the conclusion that *Citrus* seems to be the most advanced, but rather eccentric member among the genera now in existence included in this subfamily.

**337. On Certain New Species of *Citrus*.** (Japanese with English résumé). Tyôzaburo TANAKA. (Studia Citrologia **2**, 1928, 155-164).

A description of the three new species *Citrus latipes, polyandra* and *indica*.

Entries 334-337

**338. Notes on the Origination and Limitation of Species in *Citrus*.** Tyô-zaburo TANAKA. (Bull. Miyazaki Coll. Agric. and Forest. **1**, 1929, 109–114).

According to the author's view there are within *Citrus* at least three hundred standard forms of species rank which are not to be taken for hybrids, as many are inclined to think. The origin of such species may be due to a mutation occurring after seedling, the progeny produced being called a chance seedling. A few examples of such cases are given.

**339. On the Snow-rot (Yukigusare) Fungus, *Typhula graminum*, Karsten, of Graminaceous Plants.** (Japanese with English résumé). Heizi TASUGI. (Jour. Imp. Agric. Ext. Sta. **1**, 1929, 41–56, 2 pls.).

The snow-rot known by the Japanese name Yukigusare of winter wheat and barley, etc. attacks them under snow, and the sclerotia are produced in the infected parts. The plant may either be killed wholly or its young buds may survive. In spring the fungus becomes inactive, and the sclerotia lie dormant in the field. In the last part of autumn they give rise to fruit bodies bearing numerous basidio-spores. The sclerotia taken into a cold and dark place produce the fruit bodies of the same type as those of *Typhula graminum* KARST., while when the same are sown in sand or soil they produce the fruit bodies of the type for *Typhula elegantula*, KARST. The author concludes therefore for the identity of these two forms, and calls the Japanese form by the name *T. graminum* KARST.

**340. On the Premature Heading in Paddy Rice.** (Japanese with English résumé). Hirosi TERAO and Tukuda KATAYAMA. (Jour. Imp. Agric. Expt. Sta. **1**, 1929, 25–40, 3 pls.).

Premature heading of paddy rice is the phenomenon in which the seedling set in the field begins to produce panicles abnormally much earlier than usual after the transplantation from the nursery beds. This is due often to the fact that the seed-lings had remained too long in the nursery beds. In the case of premature heading the panicle is imperfect and miniature, the spikelets are few and mostly abortive, while those of the second order are the tillers of the first order are limited in growth, while those of the second order are multiplied., etc., etc. Experiments were done to study the influence of delay of transplantation of seedlings, and confirmed what was above stated. The reason why the delay will cause the premature heading is easily comprehensible, because the seedlings which remain too long in the nursery beds will exhaust their reserve nutrients, and fall into the state of starvation. Illumination of seedlings in nursery beds by electric lamps at night will hinder the premature heading, because it will retard their growth.

**341. On the Inheritance of Chlorophyll Colorations of Cotyledons and Seed-coats in the Soy-bean.** (Japanese with English résumé). Hirosi TERAO and Sadao NAKATOMI. (Japan. Jour. Genetics 4, 1929, 64–80).

Concerning the colour of cotyledons, either in seeds or seedlings as well as that of seed-coats the authors distinguish four types, 1. all three are green, 2. seed-coty-ledons are yellow, while seedling-cotyledons and seed-coats are green, 3. seed-coty-ledons and seed-coats are yellow, while seedling-cotyledons are green, 3. seed-coty-

ledons and seed-coats are yellow, while seedling-cotyledons are green, and 4. all three are yellow.

The authors have performed a number of crossing experiments on all these types in various combinations, and observed several peculiarities. These are interpreted briefly as follows.

There are two kinds of chloroplasts $Y$ and $G$. The former is able to change from green to yellow, while the latter remains always green. Such properties may be due to cytoplasm or plastids themselves; they are heritable only through the mother, not through the father, which will be easily comprehensible, if the sperm-nucleus will not be accompanied by any cytoplasm or plastid during fertilization. Besides there are two factors **H** and **C**; in the presence of both or one of them chlorophyll formation goes on normal, while in the absence of both the imperfect formation of chlorophyll pigment takes place, giving rise to the fourth type above mentioned.

The factor **H** and the chloroplast $Y$ act together to inhibit the yellow change of seed-coats, so that the second type will result. The absence of **H** ($=$ **h**) permits on the contrary the yellow change of seed-coats. It may be added that the above functions of **H** and **h** will naturally invisible when $G$ is present, in which case they will be constantly green.

### 342. A Vegetative Mutation and Maternal Inheritance of a White-margined Variegation in *Petunia*. (Japanese with English résumé). Hirosi TERAO and Nagaharu U. (Japan. Jour. Genetics 4, 1929, 86–89).

In a normally green-leaved seedling of *Petunia violacea* a variegated sectant has arisen owing to vegetative mutation. The seedling was thus divided into three parts, the sectant with green leaves, that with white-margined ones, and that with white ones. The white-margined sectant was proved to be a white-over-green periclinal chimæra. The cross of each kind of sectants with normal plants has shown that the chlorophyll deficiency just stated is heritable only maternally, and the progeny are either green or albino. It is likely that one is dealing here with a variegation belonging to WINGE's Category II. A. b.

### 343. A propos de la Propriété du Pollen chez les Hybrides entre l'*Hibiscus esculentum* et l'*H. Manihot*. (En japonais). Torao TEZIMA. (Proc. Crop Sc. Soc. Japan 2, 1928, 12–14).

L'hybridation, *Hibiscus esculentum* ♀ × *H. Manihot* ♂ donne beaucoup de graines bien mûres, dont quelques-unes germent et forment des plantes à la croissance très vigoureuse. Celles-ci sont presque totalement stériles. Les grains du pollen en sont plus grands que ceuz de deux parents. La culture artificielle sur différents milieux nutritis a montré que le pourcentage de germination du pollen des hybrides se trouve entre celui de deux parents. Les hybrides produisent une grande quantité des grains du pollen très petits et incapables de germer. Quand on met sur les stigmates du *H. esculentum* son propre pollen et celui du *H. Manihot* en même temps, on verra qu'aucune hybridation n'a lieu et seulement les plants du *H. esculentum* sont produits.

### 344. The Action of Nitrates and Ammonium Salts on Some Plants, II. The Action of Nitrates and Ammonium Salts on the Germination. Shozo TOKUDA. (Bot. Mag. Tôkyô 43, 1929, 295–305. 4 figs.).

The author has studied the stimulating action of various ammonium salts and nitrates towards the germination of seeds of *Sesamum orientale* and *Fagopyrum esculentum* at its first stage. He found that the stimulating action is greater in ammonium salts than in nitrates. As to the stimulating action the following order was observed, though in the course of time the order becomes quite opposite,

$$NO_3 > Cl > SO_4 > PO_4 \quad \text{and} \quad Ca < K < Na < NH_4.$$
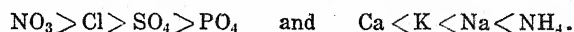
The order of the concentration in relation to the stimulating action is as follows: $0.1 < 0.05 < 0.01 < 0.005$, though in the course of time the maximum point of germination migrates to the higher concentration.

Further, in the experiments of putting small branches of *Cornus controversa* bearing winter buds in the solutions of various substances it was found that according as the latter are more or less permeable to the plasma-membrane, the buds at the upper or lower part of the branches respectively begin to open at first.

**345. On the Life-History of *Porphyra tenera* Kjellm.** Saburô Ueda. (Jour. Imp. Fisher. Inst. **24**, 1929, (139)-(142)).

The carpospores of *Porphyra tenera* which are liberated in spring from the mother frond do not pass into the resting stage, but they soon germinate and develop into small thallus. The latter which will pass the summer as such produces in autumn the monospores, to which the production of the "autumn *Porphyra*" may be due. The temperature for the development of the monospores lies between 15–20°C, the optimum being 17–18°C.

**346. On the Temperature in Relation to the Development of the Gametophyte of *Laminaria religiosa* Miyabe.** Saburô Ueda. (Jour. Imp. Fisher. Inst. **24**, 1929, (138)-(139)).

The zoospores of *Laminaria religiosa* were cultivated at the temperatures varying from 1.9° to 24.8°C, and it was ascertained that the optimum for the development of the gametophyte lies between 6–9°C.

**347. On the Growth-curve of Rice-plants in Nursery-beds.** (Japanese). Saisuke Ueda. (Proc. Crop Sc. Soc. Japan **3**, 1929, 66–76, 5 figs.).

The author has observed the change of dry weight and that of the root number of rice-plants cultivated in nursery beds for each week, and this was continued during six weeks. On the basis of the results of such measurements he has got the growth-curve $\log y = \log A + at + bt^2$ where y indicates the dry weight or the root number in t period, A that at the beginning of the experiment, a and b the rate of interest or the efficiency index in Blackman's sense, log being the common one.

**348. Notiz über eine Myxobakterie.** (Deutsch u. Japanisch). Atsushi Watanabe und Isuke Tanaka. (Bot. Mag. Tôkyô **43**, 1929, 227–228, 1 Taf.).

Beschreibung einer auf feuchtem Boden gefundenen Myxobakterie, *Chondromyces lanuginosns* Kofl. (= *Ch. Thaxteri* Faul. = *Synangium lanuginosus* Jahn) mit Abbildungen.

**349. Notes on Some Fossil Plants from Korea and China belonging to the Genera *Nilssonia* and *Pterophyllum*.** Hisakatsu YABE and Saburô ÔISHI. (Japan. Jour. Geogr. & Geogr. **6**, 1929, 85-101, 3 pls.).

The following species are described: *Nilssonia tenuicaulis* (PHILLIPS), *N.* cfr. *compta* (PHILLIPS), *N.* sp., *N.* ? sp., *Pterophyllum* aff. *propinquum* GÖPPERT, *P. contiguum* SCHENK, *P. æquale* (BRONGN.), *P. jægeri* BRONGN., *P. angustum* (BRAUN), *P. nathorsti* (SEWARD), *P.* (*Anomozamites*) *inconstans* BRAUN, *P.* (*Anomozamites*) sp.

**350. Jurassic Plants from the Fang-tzu Coalfield, Shantung, Supplement.** Hisakatsu YABE and Saburô ÔISHI. (Japan. Jour. Geol. Geogr. **6**, 1929, 103-106, 1 pl.).

The following species are described: *Coniopteris hymenophylloides* (BRONGN.), *Pterophyllum* sp. ?, Cfr. *Baiera lindleyana* (SCHIMPER), *B.* cfr. *asadai* YABE et ÔISHI.

**351. Contributiones ad Floram Formosanam.** Yoshimatsu YAMAMOTO. (Trans. Nat. Hist. Soc. Formosa **19**, 1929, 104–107).

*Alsophila acaulis* MAKINO, *Crawfurdia cordifolia* YAMAMOTO sp. nov., *Viburnum Yamadai* BARTLETT et YAMAMOTO sp. nov., *Patrinia glabrifolia* YAMAMOTO et SASAKI und *Lobelia trigone* ROXBURGH sind hervorgehoben. Die neuen Arten sind ausführlich beschrieben.

**352. Determination of the Draught Resistance of Rice Varieties by Means of Their Seed-germination in Various Solutions.** (Japanese). Morimasa YAMASAKI. (Proc. Crop Sci. Soc. Japan, No. 3, 1929, 57).

In his experiment of seed-germination of both low-land (hydrophytic type) and up-land varieties (xerophytic type) of rice in the 3% solution of $KClO_3$ at 25–28°C, the author noticed that the seeds of the latter, in general, germinate more poorly than those of the former do. Quite the same difference was also recognized when the solutions of $CuSO_4$ (3%), NaCl (0.25 mol.) and sucrose (0.3 mol.) were employed.

Further, another experiment was carried out in which the seeds of both low-land and up-land varieties were soaked in the 3% solution of $KClO_3$ for 2 days at 25°C and then rendered to germinate in distilled water. According to the results of this experiment, the seeds of the low-land varieties well germinated but were soon killed by the toxic action of the salt they had absorbed, while those of the up-land ones not only showed good germination but also survived, the seedlings sprung from them growing on without being much injured by the toxicant.

By means of such germination experiments, it may be possible, to determine, to some extent, the degree of the draught resistance of rice varieties. Author.

**353. On the Variation of Rice Varieties in the Resistance to the Toxic Action of Potassium Chlorate and Its Practical Significance.** (Japanese with English résumé). Morimasa YAMASAKI. (Jour. Imp. Agric. Ext. Sta. **1**, 1929, 1–24, 2 pls.).

The resistance of rice varieties to the toxic action of $KClO_3$ was tested by cultivating either their seedlings in its 0.01–0.1 % solutions or their leaves in its 0.05–0.3 % ones during a certain number of days. The injury was easily recognizable by the

production of brown striations along leaf veins in various grades. It was found 1. that up-land rice was more resistant than low-land rice, 2. that in the former the resistance against the toxicant and that against draught go parallel, and 3. that the late maturing varieties are more resistant than those early maturing, etc.

**354. Studies on the Abscission of the Spikelet in** *Oryza sativa.* (Japanese). Yoshito YAMASAKI. Dairen, 1928. 48 pp., 63 pls. with the Appendix, 18 pp. and 7 pls.

It is well known that in many races of rice-plants a number of grains separate off from their stalklets and fall down to the ground before harvest. This is due to the formation of a special abscission tissue in the part of the stalklet which lies between the empty glume and the glume-rudiment. The cells composing this tissue which are provided with thin walls, become lignified and brittle, so that the abscission of grains is induced by their mechanical rupture. The formation of the abscission layer takes place at first at the upper extremity of the panicle and proceeds gradually downwards. The number of cells composing the abscission tissue is variable in different races, the thrashing being naturally much easier in the cases when the number of such cells is greater than in those when it is smaller. In certain races no abscission layer at all is produced, when the thrashing is of course most difficult.

Various other interesting items are contained in this book, which are interesting chiefly from agricultural point of view. A great number of tables and curves is given.

**355. Physiological Researches on the Fertility in** *Petunia violacea* **VI. Growth of the Pollen-tubes in the Style.** (Japanese with English résumé). Sadao YASUDA. (Bot. Mag. Tôkyô **43**, 1929, 156–169, 4 figs.).

Intra-self- and cross-pollination were made on self-compatible races of *Petunia violacea*. 24 hrs. after pollination the styles of pollinated pistils were cut off at a certain distance from the stigma. It was found that in the case of intra-self-pollination the fertilization was strongly prevented in contrast to that of cross-pollination, when no such fact was recognizable. This experiment shows that the pollen-tubes grow more rapidly in the latter than in the former case. Similar experiments were performed on self-incompatible races, and it was found that the pollen-tubes of the cross-pollinated flowers were about 4 times longer than those of self-pollinated ones. Further, that the velocity of the growth of pollen-tubes was much larger in crossing than in selfing was experimentally proven, both on self-compatible as well as self-incompatible plants. Another interesting experiment consists in the comparison of pollen-tube growth in 10% sugar solution, where some tissue-juice of the style of the same flower or of flower from the plant of different line was added: the growth was much more rapid in the latter than in the former case.

**356. On the Physiology of Barley under Snow at Morioka.** (Japanese with English résumé). Sadao YASUDA. (Proc. Crop Sc. Soc. Japan **4**, 1929, 41–50, 5 figs.).

At Morioka, a city in Northeastern Japan the temperature falls sometimes to –17°C. The average depth of snow in the field during winter measures 30–40 cm. Under deep snow the temperature near the soil surface is 0°C, so that the barley

under it is protected against severe cold. When however snow is less abundant or almost wholly melted away, the temperature is lower, and the plants are exposed to severe cold.

The amount of monosaccharide in the barley increases before snowfall, but decreases rapidly under it. In the middle of March, when snow has almost wholly melted away the amount of sugar is in minimum, and the barley is likely to be attacked by cold.